Program and Summaries, Fourteenth Annual Open House and Review of Activities

D.R. MacDonald,
Editor

Report 90-3

Nova Scotia

Department of Mines and Energy

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Halifax, Nova Scotia
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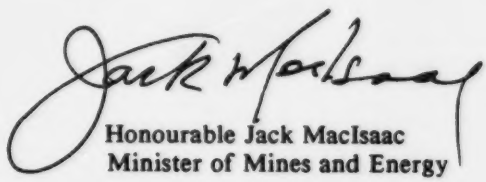
FOREWORD

On behalf of the Nova Scotia Department of Mines and Energy, it is my pleasure to welcome you to the 1990 Open House and Review of Activities. This event provides an excellent opportunity for our staff to present to representatives of the mineral industry and the general public an overview of Departmental activities in the areas of earth science and mineral resources.

This Report provides brief summaries of all major programs and presents preliminary results where possible. These programs, collectively designed to evaluate and promote the development of Nova Scotia's mineral resources, involve staff from both the Mines and Minerals and Energy Branches of the Department, as well as members of the local academic community who are involved in joint research. Most importantly, the Open House provides an opportunity to highlight projects completed under the Canada - Nova Scotia Mineral Development Agreement. We welcome the participation of Energy, Mines and Resources Canada in our Open House this year.

Nova Scotia has experienced substantial increases in exploration activity in the past few years. Several properties are in the advanced exploration stages. Also, the Gays River Mine has resumed production. We welcome the addition of copper, lead and zinc to the list of mineral commodities produced in the Province. Equally significant, however, are new developments in the industrial minerals and coal sectors, indications that our traditional mineral industry is alive and well. In this regard, it is important to note that in 1989 the total value of minerals produced was sustained at about $500 million.

The Mining Association of Canada, the Prospectors and Developers Association of Canada, the Canadian Institute of Mining and Metallurgy and related organizations like the Chamber of Mineral Resources of Nova Scotia all supported the projects carried out under the Federal-Provincial Mineral Development Agreements. We share these convictions and I am very pleased that we were able to continue some of the programs under the new $9.0 million Mineral Development Agreement that was signed in September. The presentations made at this Open House bear witness to the collaborative efforts of the Federal and Provincial Departments responsible for mineral development.



Honourable Jack MacIsaac
Minister of Mines and Energy

Nova Scotia Department of Mines and Energy
Fourteenth Annual
OPEN HOUSE AND REVIEW OF ACTIVITIES

PROGRAM

Thursday, November 15, 1990

08:30 to 14:00	Registration
08:30 to 23:00	Displays Open
13:00 to 17:00	Geological Survey of Canada Workshop on Airborne Geophysics
19:00 to 20:30	Registration
19:30 to 23:00	Reception, Cash Bar

Friday, November 16, 1990

08:00 to 12:00	Registration
08:00 to 16:00	Displays Open
08:30 to 08:35	Introduction to Review of Activities: Dr. Richard Potter
08:35 to 09:15	Update on Petroleum, Natural Gas, and Coal Exploration and Development
09:15 to 09:25	Greetings and Welcome: Dr. John Laffin, Deputy Minister
09:25 to 09:45	Programs of the Canada - Nova Scotia Cooperation Agreement on Mineral Development
09:25 to 09:35	Energy, Mines and Resources Canada Activities: Al Clarke
09:35 to 09:45	Department of Mines and Energy Activities: Richard Potter
09:45 to 10:00	Work of the Geological Survey of Canada in Nova Scotia
10:00 to 10:20	BREAK
10:20 to 11:10	Mineral Exploration Update; Description of Work on Industrial Minerals, Land Use, Mineral Inventory
11:10 to 12:10	Description of Bedrock and Surficial Mapping Projects and Public Awareness Activities
12:10 to 12:20	Questions and Comments
12:30 to 14:00	LUNCHEON Speaker: Honourable Jack MacIsaac, Minister of Mines and Energy
14:00 to 16:00	Displays Open
16:00	Open House Closes

OTHER ACTIVITIES DURING OPEN HOUSE

Thursday, November 15, 1990

Chamber of Mineral Resources of Nova Scotia

11:30 to 13:00 Lunch and Presentation of Public Awareness Campaign
11:30 to 12:00 Cash Bar Reception
12:00 to 13:00 "Deli Lunch" and Campaign Presentation

Geological Survey of Canada

13:00 to 17:00 Geological Survey of Canada Workshop on Airborne Geophysics, Co-Sponsored by the Geological Survey of Canada, Chamber of Mineral Resources of Nova Scotia, Department of Mines and Energy, and The Public Information Program, Canada - Nova Scotia Cooperation Agreement on Mineral Development
13:00 to 13:10 Welcome by Ken Collison, President, Chamber of Mineral Resources of Nova Scotia
13:10 to 15:00 Talks by Geological Survey of Canada Geophysics Division Personnel
15:00 to 15:20 BREAK
15:00 to 17:00 Hands-On Demonstrations with Maps and Computers

Mining Society of Nova Scotia

17:30 to 20:00 Annual General Meeting of the Halifax Branch, Mining Society of Nova Scotia
17:30 to 18:00 Reception
18:00 to 20:00 Dinner, Business Meeting, Speaker

Friday, November 16, 1990

Professional Registration

14:15 to 15:15 Open Meeting about "Professional Registration" of Earth Scientists; Sponsored by the Canadian Geological Council (CGC);
ALL ARE WELCOME.
Short talks will describe the legislation now in effect in Newfoundland and its influence on mineral exploration geologists, geophysicists, etc. Other talks will describe the CGC's attempt at developing a national program of professional registration. Finally, a representative of the Association of Professional Engineers of Nova Scotia (APENS) has been invited to speak about the possible association of engineers and earth scientists in one professional body similar to the Alberta association.

CARBONIFEROUS LAKES AND MIRES: EXAMPLE FROM THE HARBOUR SEAM INTERVAL, SYDNEY COALFIELD, NOVA SCOTIA

B. J. Cox, D. J. MacNeil, P. K. Mukhopadhyay[1] *and R. D. Naylor*

Regional variation in the thickness (1.7 to 4.5 m) of the Harbour Seam in the Sydney Coalfield, Nova Scotia, is related to (1) earlier development of the 'Harbour mire' on the east side of the coalfield and (2) the local termination of peat accumulation by formation of lakes on the mire surface. Micro- and macro-petrographic analysis of the seam indicates that both local fluctuation and regional changes in groundwater level occurred within the Harbour paleomire. A higher percentage of gelocollinite with respect to telocollinite in thinner seam sections is indicative of high groundwater levels, whereas thick seam sections are rich in inertinite and relatively depleted in gelocollinite, suggesting lower average water levels. Thin (mm to cm scale) liptinite- and/or inertinite-rich dull bands, which can be traced over much of the coalfield, provide evidence for widespread rises in groundwater levels within the mire. These elevated groundwater levels were responsible for the local development of long-lived, protected lakes on the mire surface. These lakes were infilled by carbonates, organic-rich mud and sandy lacustrine delta deposits. The carbonates and organic-rich mud may have been deposited while peat was still accumulating in the adjacent mire.

This revised concept of the Harbour paleomire, based on variability of vitrinite, inertinite and liptinite submacerals, is an extension of the petrographic work of Peter Hacquebard, Alex Cameron and J. Roger Donaldson, who pioneered petrographic analysis of coals of the Sydney Basin.

1 Global GeoEnergy Research, R.P.O. Box 23070, Dartmouth, Nova Scotia B3A 4S9

COMPUTER MODELLING OF THE SYDNEY AND PICTOU COALFIELDS, NOVA SCOTIA[1]

J. D. Hughes[2] and D. J. MacNeil[3]

Comprehensive computer databases containing geological and analytical data collected for Nova Scotia's coalfields over the past century have been developed since 1985 through the first Canada-Nova Scotia Mineral Development Agreement. Computer modelling technologies developed through work on the Geological Survey of Canada's National Coal Inventory are being applied to the analysis of these data to develop three-dimensional digital models defining the geological, economic and environmental characteristics of these coalfields.

In the Sydney coalfield, for example, information is available from more than 800 boreholes drilled onshore, from drill ships and from existing underground mine workings, in addition to geological and analytical data collected from 7000 underground locations and from surface outcrops. The completed model will define the geometry, areal distribution and quality of 47 correlatable coal beds throughout a 50 km by 30 km area. The model can be displayed as maps and cross sections, and can be used to determine coal resource quantities subdivided by a wide variety of geological, economic and environmental constraints. It can also be used to predict the outcome of future exploration boreholes or mine workings, and hence can help to optimize the cost/benefits of such work. Downloading of the digital geological model into a microcomputer-based Geographic Information System (Tydac SPANS) and an image-analysis system (PCI Easi/Pace) allows integration with cultural, land capability, satellite and/or airborne datasets, which provides a wide variety of further display and reporting capabilities.

A prototype digital model for the Sydney Coalfield has already been produced and the final version will be delivered in early 1992 through funding from the Canada - Nova Scotia Cooperation Agreement on Mineral Development. The computer database and digital geological model for the Pictou coalfield will be available in late 1992.

1 Funded under the Canada - Nova Scotia Mineral Development Agreement 1984-1989 and the Canada - Nova Scotia Cooperation Agreement on Minderal Development 1990-1992, and by the Office of Energy Research and Development, Energy Mines and Resources Canada

2 Geological Survey of Canada, Calgary, Alberta

3 Nova Scotia Department of Mines and Energy, Sydney Mines, Nova Scotia

PETROLEUM RESOURCES SECTION UPDATE

D. J. MacDonald

The Petroleum Resources Section is responsible for monitoring, evaluating and regulating petroleum exploration and development activities onshore and, in conjunction with the Canada-Nova Scotia Offshore Petroleum Board, offshore Nova Scotia. Over the past year, the Section has been involved in the regulatory approval process for the Cohasset-Panuke offshore oil project. Other activities have included a number of research studies, creation of information and databases to assist industry, and preparation of oral presentations and poster displays at technical conferences which have served to focus attention on Nova Scotia's petroleum potential.

ONSHORE ACTIVITY

Consultants A.G.R.E.N. completed the drilling of their South Noel #1 exploratory well in April 1990, having reached a depth of 345 m. This was drilled as a requirement under the terms of the exploration agreement with the Province. The location of the well was the result of a refraction seismic program conducted in the area in 1986. The rights holder has negotiated a further three year term, which includes a commitment to drill another well.

The consortium of New World Ventures, Far Away Resources and Bird Oil is entering the second year of its three exploration agreements and has filed first year reports with the Section. Second year activity requirements include seismic or other equivalent investigative work.

The onshore source rock study, consisting of a report and maps, will be completed by spring. Some interesting findings and trends have emerged. The report will assist industry in their future exploration efforts by providing a significant geochemical database.

Staff have begun joint work with the Coal Section in the area of assessing the coal bed methane resource. Activity elsewhere in Canada, and particularly in the U.S., has shown coal bed methane to be one of the energy resources of the future. Nova Scotia, with its vast coal deposits in a number of sedimentary basins, has undetermined potential.

OFFSHORE ACTIVITY

Staff have been involved in review of the development proposal for the Cohasset-Panuke offshore oil fields. The newly formed Canada-Nova Scotia Offshore Petroleum Board has given its approval of the development plan submitted by the project's proponents, London and Scottish Marine Offshore (LASMO) and Nova Scotia Resources Limited, subject to some 24 conditions. The federal and provincial energy ministers have endorsed this proposal.

On the exploration side, two seismic programs have been carried out by LASMO and another by Mobil Oil in the Sable Island area. LASMO is planning to drill two exploratory wells commencing in January, to be followed by four development wells on the Panuke field.

The Section has undertaken two detailed studies of the hydrocarbon potential of the Jurassic carbonate bank that runs the length of the Scotian shelf. These studies involve the seismic detection of porosity development within the carbonate and demonstrate the potential for gas-filled, fractured dolomite. Zones 10 m thick and having porosity in the range of 11-14% can be detected. The procedures and results have been presented at several technical conferences in Canada and the United States, and have resulted in several oil company enquiries and discussions.

HYDROCARBON GENERATION OF COAL FROM TWO SEDIMENTARY ENVIRONMENTS OF TEXAS AND NOVA SCOTIA[1]

P. K Mukhopadhyay[2], P. G. Hatcher[3], J. R. Gormly[4] and J. H. Calder.

Selected coal and coaly shale, of varying maceral composition, from the Tertiary Wilcox Group (deltaic-strand plain) of Texas and Late Carboniferous Cumberland Group (intermontane fluvio-lacustrine) of Nova Scotia, were compared by using various organic geochemical parameters (Rock-Eval pyrolysis, nuclear magnetic resonance, anhydrous and hydrous pyrolysis, gas chromatography). Three coal types (humic, mixinitic and sapropelic), which are related to maceral affinity association, show distinct pyrolysis yield, hydrocarbon distribution pattern and possible variation of structural configuration. Mixed coal from Texas and Nova Scotia (R_o = 0.75%) shows similar long-chain methylene, alkyl-o, aliphatic/aromatic ratio in nuclear magnetic resonance. Both mixinitic and sapropelic coals have less phenolic compounds. Prist-1-ene (from anhydrous pyrolysis) is related to oxidation rather than plant type. Hydrous pyrolysis and petrographic data show the mechanism of primary migration within the coal network. Correlation of organic petrography and geochemistry suggests that hydrocarbon generation from coal samples of two different ages and depositional environments is related to maceral association; for example cutinite-rich coal samples may have similar hydrocarbon potential and structural configuration, even though they originated from different flora.

1 Funded by Nova Scotia Department of Mines and Energy, Pennsylvania State University and Mobil Research and Development Corporation
2 Global GeoEnergy Research Ltd., R.P.O. Box 23070, Dartmouth, Nova Scotia B3A 4S9
3 Fuel Science Program, Pennsylvania State University, University Park, PA 16802
4 Mobil Research and Development Corporation, Dallas Research Laboratory, Dallas, Texas 75244-4312

GYPSUM/ANHYDRITE PROJECT[1]

G. Adams

The primary objective of this project, as established in 1985, is to carry out an inventory of gypsum and anhydrite resources of the Province. The final report on this investigation is now in the last stages of editing and should be published within six months.

Subsequent detailed investigations, including limited diamond-drilling, to further evaluate gypsum and anhydrite resources in selected areas were initiated in 1990. A dozen locales were chosen on the basis of geological, geophysical and social factors. Drilling commenced on the first area in mid July and should be completed by early October 1990. Initial results of this program are encouraging and a detailed report of findings will be made available this fall.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

AUTOMATION IN THE MINERAL DEVELOPMENT DIVISION[1]

L. Crust

BACKGROUND

The development and use of computerized routines and applications within the Mineral Development Division has continued to progress over the past year. As of the fall of 1990 our local area network will include nine workstations within our own division and three workstations in the Mining Engineering Division, and will be linked to a network to be installed in the Energy Branch. The purchase of a fourth micro-computer (by the Mining Engineering Division) for the Stellarton office has brought the total number of micro-computers there to four.

As before, our major applications for computers remain database management (using Advanced Revelation), word processing (using WordPerfect), communications (using Pibterm), spreadsheet (using Lotus 123) and business graphics (using Harvard Graphics).

WORK IN PROGRESS

Work is continuing on the development of an automated system of record-keeping for the Registry of Mineral and Petroleum Titles. Databases for storing information on applications, licenses, leases and transfers are now in use, and it is anticipated that soon automated routines on the computer will perform the search of title involved in title registration.

The Library card catalogue is now fully automated and all new acquisitions are entered directly into the computerized system. Acquisition lists and books of Library holdings are automatically generated, and a new workstation is about to be installed in the Library to allow the public to perform on-line searches of the Library catalogue as well as of other databases. The Library is also able to access the Novanet catalogue, giving on-line access to listings of materials held by local universities.

Other databases currently on the system or under development include drillholes, metallic minerals, maps, production statistics and various land use databases.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

METALLIC MINERAL OCCURRENCES DATABASE ACTIVITIES[1]

G. DeMont

A new program for field checking and sampling metallic mineral occurrences was initiated in April 1990 under the Canada - Nova Scotia Cooperation Agreement on Mineral Development. The objective of the program is to obtain the field data required for revision of the metallic mineral occurrences cards and metallic minerals database. Field checking will provide accurate occurrence locations, occurrence descriptions, and samples for geochemical and petrographic analyses.

A full field program of field checking and sample collection of mineral occurrences in Cape Breton Island began in July 1990. Thirty-one documented metallic mineral occurrences were checked in Cape Breton between 1 July and 30 September 1990. Three new metallic mineral occurrences were also examined and sampled. Nine of the documented occurrences could not be located in the field. The geology at the location indicated on the nine cards matched that described in the literature; however, no mineralization was visible in the rocks at the indicated locations.

The confirmed occurrences have been sampled, chained in to fixed reference points, and in most cases photographed. Host rock and mineralized samples were taken where available. Samples taken will be sent for chemical analysis and the results will be incorporated in the metallic minerals database. Hand specimens will be available for viewing at the NSDME libraries in Halifax and Stellarton. A photographic catalogue of the occurrences will also be available at these two locations.

In order to improve the quality and reliability of information in the metallic mineral occurrences data cards and database, which began in 1987, the program of systematic examination of references coupled with selected field checking continued over the period 1 August 1989 to 30 June 1990. During this period 171 metallic mineral occurrence data cards were researched and checked, and limited field checking was conducted in parts of Cape Breton Island. One hundred thirty-three cards were revised and updated, 38 cards were eliminated from the dataset and 10 new metallic mineral occurrences were documented. Since this program began in fiscal year 1987-88, under the Canada - Nova Scotia Mineral Development Agreement, a total of 743 metallic mineral occurrence cards have been researched and checked, 604 cards have been updated, 288 revised cards have been entered in the database, 139 cards have been eliminated from the dataset and 46 new metallic mineral occurrences have been documented, covering the following map sheets: 11D/12; 11E; 11F/5, 9, 10, 11, 12, 13, 14, 15 and 16; 11G/13; 11J/4; 11K; 11N/1 and 2; 21A/10; and 21H.

The department is also conducting a program to assess metallic mineral occurrences in Carboniferous rocks (cf. Ryan, this report) under the Canada - Nova Scotia Cooperation Agreement on Mineral Development. Data collected under this program will also be used to update the metallic minerals database. Occurrences in the New Glasgow - Stellarton - Merigomish area on NTS map sheets 11E/10 and 11E/09 were field checked during the summer of 1990.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989 and the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

DRILL CORE LIBRARIES

J. D. Langille

The Nova Scotia Department of Mines and Energy maintains diamond-drill core library facilities at four locations in the Province. Two facilities in Stellarton, Pictou County, are located at the Department's regional office building on Bridge Avenue and on Acheron Court in the Stellarton Industrial Park. The other two facilities are located in the Debert Air Industrial Park, Colchester County, and near Malagawatch, Inverness County. Most activity is centered at the main facility in the Stellarton Industrial Park. The Bridge Avenue location contains mainly coal core. The Malagawatch building holds Cape Breton salt core and the Debert location is gradually becoming a sample storage site as core is transferred to Stellarton.

As ongoing operations permit, all core library data are being computerized. This will allow staff faster access to a wide variety of data and greater manipulative ability. Also, as core is received and other acquired core is reviewed, it will be photographed so that regardless of the disposition of the core, a permanent record will exist.

All staff is permanently stationed in Stellarton and only the two Stellarton facilities are staffed on a regular, full-time basis. All core in the Stellarton Industrial Park is stored on wooden pallets and moved with a propane-powered forklift. Some prior notice of an intended visit is appreciated to accommodate all users in an efficient manner. Visits to Debert and Malagawatch may take longer to arrange but usually can be handled within 48 hours. For further information on core library activities or requests to visit, please telephone Jim Langille, Core Library Supervisor (902) 752-4842, or John McMullin, Regional Geologist (902) 752-8429, Fax (902) 755-3158, Nova Scotia Department of Mines and Energy, Stellarton.

CANADA-NOVA SCOTIA COOPERATION AGREEMENT ON MINERAL DEVELOPMENT[1]

Nova Scotia Department of Mines and Energy staff geologist W. Palmer was joined during the year by geologist D. Weir. They are assisted by mineral technician J. O'Leary. This staff continued to examine and evaluate packages of diamond-drill core from areas of the Province where substantial drilling has taken place. These evaluations will permit the eventual disposal of some core and make room for additional core to be received and processed.

During 1990, work proceeded on report writing and tabulation of drillhole statistics on a large package of core from the Silver Mine/Yava area, Cape Breton County. Also, a package of exploration core from the Walton area, Hants County, was processed.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

MINERAL INVENTORY

N. A. Lyttle

BIBLIOGRAPHIC DATABASE ACTIVITIES

(J. M. Freeman, N. A. Lyttle, S. Saunders)

Indexing and on-line data entry into GEOSCAN continued for Nova Scotia Department of Mines and Energy (NSDME) bibliographic records. GEOSCAN is a bibliographic database that provides access to publicly available geoscience literature concerning the Canadian landmass and offshore regions. The database presently contains 120,000 records and is cooperatively produced from the indexing contributions of 13 federal, provincial and professional geoscience organizations located throughout Canada. The Geological Survey of Canada, through the National GEOSCAN Centre, coordinates these indexing activities and provides computer resources in support of this project.

During the period 1 August 1989 to 31 July 1990, 847 new NSDME records were added to GEOSCAN. These records consisted of 527 assessment reports, 25 open file maps, 46 open file reports, 125 publications, 86 theses, 18 journal literature references, 3 internal documents and 1 book, representing an 8.0% increase in the Nova Scotia component of the database. As of 31 July 1990 the database contained 11,355 NSDME records consisting of 5138 assessment reports, 2245 publications, 1290 journal literature references, 1027 open file maps, 908 open file reports, 16 open file illustrations, 723 theses, 6 internal documents and 1 book.

The bibliographic index, Report 90-2: *Index to Assessment Reports, Publications, Open File Maps and Open File Reports for 1989* was released in May 1990. Work on a ten-year index, covering the period 1981 to 1990, is in progress.

GEOLOGICAL AND GEOPHYSICAL MAPS DATABASE

(P. L. LeBlanc, N. A. Lyttle)

During the summer and fall of 1990, a project was conducted to identify, index and enter into a database all pertinent information on published bedrock geology, surficial geology and airborne geophysical maps on Nova Scotia. Six data files have been created containing information on NSDME bedrock geology maps (52 maps), Geological Survey of Canada (GSC) bedrock geology maps (121 maps), Fletcher-Faribault Series bedrock geology maps (121 maps), surficial geology maps (31 maps), GSC colour total field and vertical gradient aeromagnetic maps (34 maps) and GSC red-line total field and vertical gradient aeromagnetic maps (210 maps).

The information in each map data file, in the form of a data sheet for each map plus an index map showing the plotted location of each map in Nova Scotia with respect to the National Topographic System grid, will be released as a series of open file reports (OFR 90-011 to 90-016) in the latter half of 1990. The open file reports will be available in hard copy and on microfiche (index map plus data sheets), on white prints (index maps only) and on diskette (data sheets only).

VARIOUS COMMODITIES PROJECT[1]

R. MacDonald

The Various Commodities Project was initiated to help further identify and increase the database on several industrial mineral deposits within the Province. In-depth studies have been conducted on several of these deposits including the Glencoe limestone/dolomite deposit and the Chegoggin Point silica deposit. A number of smaller, lesser known industrial mineral deposits have been investigated and promoted to industry, especially deposits containing commodities sought-after in the market place.

The author has also served as a promoter and resource information person to established companies within the Province, companies exploring our industrial mineral potential and other government agencies promoting our Province's resources.

SUMMARY OF INVESTIGATIONS

Limestone and dolomite deposit investigation and promotion represents a large portion of the Various Commodities Project. The project has shown that Nova Scotia has many large, high quality, speciality grade deposits of limestone and dolomite. The exceptional high quality of some Nova Scotian deposits, combined with the potential to transport large tonnages economically by sea in large vessels, places Nova Scotia on the doorstep of markets developing worldwide.

Nova Scotia also contains high quality deposits of silica, garnet, andalusite, barite and mica, which also have been explored and promoted. The Nova Scotia Department of Mines and Energy database has been continually upgraded for the commodities included in the project's mandate. Future work will be directed at continuing studies on commodities in high demand and also provincial deposits of industrial minerals that have future potential but at present are in a depressed market situation.

PUBLICATIONS

A summary of the major limestone and dolomite deposits of Nova Scotia was updated, revised (from OFR 86-064) and released as an open file report (OFR 90-019). A report on the composition of the heavy mineral sands of the Shubenacadie River was released (OFR 89-020). Reports of exploration and diamond-drilling programs on the Chegoggin Point, Yarmouth County, silica deposit and Glencoe, Inverness County, limestone and dolomite deposit are in final preparation and due for release shortly as open file reports. The final report of the Various Commodities Project, highlighting fourteen different industrial minerals found in deposits within Nova Scotia having development potential, is in preparation.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

MINERAL EXPLORATION MONITORING

P. D. McCulloch and J. M. McMullin

Mineral exploration and development work in Nova Scotia during the first nine months of 1990 remained at roughly the same level of activity as in the previous year, although over-all expenditures dropped from $24 million in 1989 to an estimated $10 million for 1990. The apparent discrepancy in expenditures versus activity is reflected in a partial shift from advanced exploration and development projects to lower budget grassroots programs. A total of 6500 general claims were staked during the first half of 1990, down markedly from the 11,783 claims staked during the same period in 1989.

A significant decrease in gold exploration was evident this year as part of a trend that began in mid 1988 following a downturn in the price of gold and the failure of several properties to advance beyond the development stage. This decrease in activity was offset to a limited degree by a renewed interest in base metals, with market prices of the traditional metals having strengthened significantly since mid 1987. Several companies that were active in gold exploration in the Meguma Group during 1986-89 have shifted their emphasis to base metals. Advanced gold exploration programs were continued on the Upper Seal Harbour gold property in Guysborough County, operated by Exploration Orex Incorporated, and the Caribou gold property in Halifax County, operated by Antioch Resources (N.S.) Limited. Both projects were put on hold early in 1990 pending the raising of additional financing. Inco Exploration and Technical Services Incorporated continued a detailed exploration program for gold in the McMillan Flowage area of the Cape Breton Highlands.

Exploration for base metals demonstrated a modest increase in 1989 and this trend has continued in 1990 with a number of significant projects being undertaken throughout the Province. Highlights of the renewed interest in base metals includes the re-opening of the Gays River lead-zinc mine by Westminer Canada Limited, the re-evaluation of several known base metal occurrences including the Smithfield and Jubilee deposits, and the continuing work by several companies for base metals and gold in the Rocky Brook area of the Cape Breton Highlands.

Exploration for industrial minerals, including limestone, gypsum and several other commodities, has continued at roughly the same level of activity as in recent years. Work was undertaken primarily by local producers to expand on current reserves. Work is being continued by Curragh Resources Incorporated (Westray Coal Division) on an underground thermal coal mine at Plymouth, Pictou County. Delays in reaching agreements on funding slowed progress on the project for approximately one year; however, development and construction work is now underway, with first deliveries of coal scheduled for the summer of 1991.

AGGREGATE QUARRY POTENTIAL IN NOVA SCOTIA[1]

G. Prime

The populated centres of our Province are the major markets for aggregate, due primarily to the high level of activity in the construction industry. Most of the materials are used in residential and commercial building construction, highway construction and highway maintenance. As the population base in our towns and cities expands, the demand for aggregate materials will also increase, accompanied by the encroachment of residential and commercial development on the resource land. This growth produces increased pressure on aggregate resources through reserve depletion and resource land sterilization. These problems are of serious concern and are the subject of the current aggregate program.

At present, granular aggregate represents two thirds of annual aggregate production in the Province; however, quarried and crushed stone is becoming increasingly popular in the market. The reasons for this include the depletion of high quality gravels and the consistency in quality exhibited in bedrock deposits. Furthermore, a substantially greater depth can be mined in bedrock deposits, resulting in large reserves underlying small surface areas, thus minimizing disruption of the landscape.

As a result of the need for new sources of aggregate and the trend toward quarried products, the aggregate program is focusing attention on bedrock potential near the major aggregate markets of the Province. The main goals will be to determine the suitability of various bedrock types for crushed stone and identify areas where quarries might be developed. In this way a database can be generated to provide industry with alternatives for meeting its aggregate needs.

The bulk of the work during the 1990 field season was conducted in the Halifax-Dartmouth area, continuing the field investigation initiated in 1988. Both bedrock and quarry exposures were examined and quarry personnel interviewed. A series of bedrock samples was collected, including representative samples of each rock type and samples from areas that offered quarry potential. At present, the samples are being processed for analysis.

Bedrock potential was also investigated during the 1990 field season in the Bridgewater, Amherst and Antigonish areas, with several samples being collected. Finally, preparations are being made for a drilling program along the north side of the Cobequid Highlands to take a more detailed look at some of the bedrock potential in that area.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

SEDIMENT-HOSTED COPPER-SILVER OCCURRENCES IN NORTHERN NOVA SCOTIA[1]

R. J. Ryan

The objectives of this study are: (1) to update the database on Cu-Ag occurrences in Nova Scotia, (2) to undertake a detailed examination of the largest tonnage deposit, at Canfield Creek, and (3) to develop exploration models for these occurrences, extrapolated from metallogenic models based on integrated geological, isotopic and thermal studies of the mineralization. During the past field season occurrences in the New Glasgow and Stellarton areas have been examined and the results will be incorporated with the existing database from the Cumberland Basin. The occurrences are of two types: (1) sandstone-hosted solution front occurrences, and (2) shale-hosted Kupferschiefer type occurrences. The mineralogy of these two types is identical and there is little doubt that they are manifestations of the same mineralizing mechanism.

Detailed examination of the Canfield Creek deposit (300,000 tons of 1.2% Cu) has revealed that many of the drillholes in the grid were not drilled to a sufficient depth to intersect the ore horizon. The ore calculations for the deposit are therefore conservative and a re-evaluation of the reserves is in progress. Study of the Canfield Creek core has also confirmed the presence of an upper pyrite-sphalerite zone in the ore deposit. The presence of such vertical zoning suggests that the deposit may be laterally zoned as well, with potential existing for Ag- or Zn-rich zones down-dip of the drilling. Preliminary thermal, isotopic and mineralogical studies of the occurrences indicate that the mineralization was low-temperature. Fission-track age dates and time-temperature paths for the strata suggest that the mineralization was related to a Late Permian to Triassic erosion event which allowed for deep penetration of oxidizing waters in the basin. Various models are now being examined and evaluated.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

THE RELATIONSHIP BETWEEN GRANITE-TILL CLAST COMPOSITION AND MATRIX GEOCHEMISTRY, AND THE UNDERLYING GRANITOID ROCKS OF THE CENTRAL SOUTH MOUNTAIN BATHOLITH[1]

F. J. Boner, M. A. MacDonald and P. W. Finck

A previous study by Graves *et al.* (1988) focused on the surficial geology overlying the Halifax Pluton of the eastern South Mountain Batholith. The study compared till clast geology and matrix geochemistry (-230 fraction) of granite tills to the geochemistry and geology of the underlying bedrock. It also determined that clast composition of the locally-derived Granite Till B closely reflected the underlying bedrock, primarily due to short renewal distances (<500 m). These tills, however, did not reflect the geochemical composition of the specific granite types from which they were derived.

A similar study was undertaken in the central portion of the South Mountain Batholith to establish if the results of Graves *et al.* (1988) could be applied to the entire batholith. The study area included N.T.S. map sheets 21A/10 and 21A/15. The dominant glacial deposit in the study area is a granite ground moraine. Clasts in this unit are derived from local bedrock sources and/or older glacial deposits and have short renewal distances (<200 m). 'Pure' granite tills containing at least 90% of one granite clast-type were used for the study. The till samples were divided into the same three major clast-type groups as used in Graves *et al.* (1988). The first group includes biotite granodiorite, biotite monzogranite and muscovite-biotite monzogranite and is referred to as BMG. The second group contains coarse grained muscovite-biotite leucomonzogranite and is termed CG2M. The third group, consisting of fine grained muscovite-biotite leucomonzogranite and muscovite leucogranite, is referred to as FG2M.

Initial results indicate that detailed clast geology accurately reflects the underlying bedrock geology as found in the Halifax Pluton study. These data aid in the determination of glacial transport direction and dispersion as well as in delineating bedrock boundaries in areas of poor exposure. Geochemical analyses for 52 BMG, 15 CG2M and 13 FG2M till samples were compared with published analyses for corresponding bedrock types. In contrast to the Halifax Pluton study, our data indicate that: (1) tills subdivided by granite-clast type (i.e. BMG, CG2M and FG2M) can be distinguished by the concentrations of selected trace elements (e.g. Zr, Hf, Ce, La, Rb, Ba) in their matrix, (2) differentiation patterns observed in bedrock are reflected in the till matrix geochemistry and (3) anomaly/background 'threshold' levels can be statistically derived for each lithologically distinct till type.

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1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989 and the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

CONTROLS ON GOLD MINERALIZATION AT THE TANGIER GOLD MINE, HALIFAX COUNTY[1]

M. C. Corey, P. K. Smith and R. F. Mills

The Tangier Project was proposed to initiate study into the styles and controls of gold mineralization at the Tangier Mine owned by Coxheath Gold Holdings Ltd. Gold mineralization at Tangier occurs within several types of quartz veins, including: bedding-parallel veins, quartz-breccia zones associated with sub-vertical NW-trending shear zones and angular veins which are related to high grade ore shoots where they intersect bedding-parallel veins. This point of intersection often results in structures referred to as 'jump-overs' since they cross stratigraphy within and between veins. These features coincide with a marked increase in gold concentration, but so far have a poorly understood geometric configuration. Coxheath reports that three confirmed jump-overs occur within the Whin vein system, which is one of three veins that were mined (Coxheath Gold Holdings Ltd., Annual Report, 1989). Since the underground workings are currently flooded and the only complete core sections are five holes drilled by the Sullivan Mining Group in 1983 east of Copper Lake, Nova Scotia Department of Mines and Energy has embarked on a five hole diamond-drilling program. The holes are spotted north of Copper Lake, approximately 60 m west of the western limit of Coxheath's underground development. These holes are intended to (1) allow definition of the stratigraphy of the deposit, which is crucial in determining and predicting the nature of the quartz veins and (2) obtain complete sections of the vein packages and hopefully an ore shoot in order to pursue detailed structural, mineralogical and geochemical studies.

In conjunction with the drilling, sludge samples are also being collected at 10 ft. intervals. Treatment of these samples will include concentration of heavy minerals by superpanning, followed by identification of selected mineral grains by scanning electron microscope.

Along with diamond-drilling, other lines of investigation are also being followed. Of special interest are the characteristics of the many angular veins (quartz ± carbonate ± chlorite) occurring within the Tangier Mine. Information such as vein orientation, thickness, depth and stratigraphic location, relationship to bedding parallel veins and associated mineralogy is being compiled from drill logs and underground geological maps. Other items of interest include documenting the types and styles of alteration and the chemistry of gold and its associated mineral assemblage. Preliminary mineral chemistry from pyrrhotite samples indicates that two distinct types occur. One is characterized by a high Fe concentration and is strongly magnetic, whereas the other type is enriched in Bi, Cu and Pb.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

EDUCATION AND PUBLIC AWARENESS[1]

H. V. Donohoe, Jr.

Developing the public's understanding and appreciation for the mineral resources, geology and mineral industry in Nova Scotia is the essential part of the Education and Public Awareness Program. The public includes people in government, schools (students and teachers), and exploration and mining companies, as well as residents and visitors. Providing a program of activities, displays and talks for these diverse groups is challenging.

During 1990, the Education and Public Awareness Group provided a wide range of activities that reached more than 34,000 people. During the year, two field trips, five school lectures, nine interpretive walking tours, four displays, a gold panning course, five seminars and two workshops for teachers were prepared and presented. The principal theme of all these activities was the mineral industry: its importance and relevance to Nova Scotia and Canada. Describing and interpreting the geology and mineral resources of the Province and the activities of the Department of Mines and Energy are the other parts of the theme presentations.

Other activities involved the preparation of a final version of *The Mining Kit* for distribution to science teachers in Nova Scotia schools, preparation of teachers' guides for the Atlantic Geoscience Society's videos, work through a committee on the development of a gold discovery centre on the Eastern Shore and planning for the 1991 Mines Ministers' Conference to be hosted by the Department. The final project of the Public Information Program of the Canada - Nova Scotia Mineral Development Agreement (CNSMDA) was a colourful poster about mining and minerals in Nova Scotia. The poster was a federally funded project under the CNSMDA with major input from the provincial side of the Public Information Program.

The work of the Education and Public Awareness Group in the Department increases the knowledge of Nova Scotia's mineral resources, geology and mineral industry. This work allows a broader understanding of the importance and influence of minerals and mining in everyday life and future planning. The Education and Public Awareness Group works closely with many groups, government agencies and individuals to foster this understanding and appreciation.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

QUATERNARY MAPPING, WESTERN CAPE BRETON HIGHLANDS: PRELIMINARY OBSERVATIONS OF RESIDUAL MATERIALS[1]

P. W. Finck and N. MacDow

Mapping at a 1:50 000 scale north of Fielding Road and west of Highland Road in the western Cape Breton Highlands commenced during July 1990. Observations consistent with regional mapping by Grant (1988), depict this area as one map unit of rubble (felsenmeer), with smaller undifferentiated areas of grus, till and rare, small bodies of saprolite. The following are some of the authors' observations on the residual deposits encountered during a more detailed investigation.

Felsenmeer, the predominant residual material in the study area, is usually found on top of smoothly rounded hills. In flat road cuts it appears as highly angular, cobble sized fragments of frost shattered bedrock. Road sections of felsenmeer reveal large angular bedrock blocks up to 2 m in diameter (Grant, 1988) transitional with increasing depth to fractured *in situ* bedrock. Felsenmeer may have formed during harsh climatic conditions occurring just prior to Late (?) Wisconsinan glaciation. Alternatively it may have formed prior to the development of a regional vegetation cover following erosion of saprolite and grus on the more exposed hilltops and ablation of the last ice sheet.

Grus forms from *in situ* granular disintegration of granitic rocks by biotite hydration and fracture of adjacent grains of quartz and feldspar. In the study area the best exposures of grus were within medium grained biotite granodiorite and biotite monzogranite of the West Branch North River Pluton mapped by Jamieson *et al.* (1987). Exposures of grus are grey, massive and fresh, with the superficial appearance of the parent bedrock. Upon excavation the grus disintegrates into pebble - sand size crystal fragments of the original granitic material. A 238 m long and 1.5 m deep washout located at the western end of Center Road reveals that grus may be transitional to saprolite. Near the surface the residual material is reddish-brown to yellowish-brown, soft and friable. With increasing depth the residual material becomes grey, massive and has iron staining along well-developed joint surfaces. In contrast with exposures along the Highland Road, this section reveals intense glacial tectonic deformation.

Saprolite is a soft, earthy, clay-rich residual deposit formed by isovolumetric weathering characterized by preservation of primary structures and pseudomorphs of original minerals. The authors observed several exposures of reddish-brown to yellowish-brown saprolite and dark greyish-brown saprolite. The best exposed section was noted by Grant in 1974 (McKeague *et al.*, 1982) on Second Forks Brook Road South. Most saprolite in the study area, including the Second Forks Brook section is believed to show evidence of intense glacial tectonic deformation.

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1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development

INHERITANCE AND OVERPRINTING: CONTROLLING FACTORS OF TILL GENESIS IN NOVA SCOTIA[1,2]

P. W. Finck and R. R. Stea

Wisconsinan tills in Nova Scotia were formed by several Maritime ice sheets. The texture, provenance and dispersal characteristics of these tills were controlled by bedrock source areas, ice sheet dynamics, incorporation of older till material (inheritance), and reworking by younger ice flows (overprinting).

Early ice sheets formed matrix-dominated tills, transported in part englacially with red mud matrix and erratics derived from source areas up to 120 km up-ice. Englacial transport is further indicated by 25 km skip zones where local bedrock is not reflected in the till clast content. Reworking of these tills by younger ice flows overprinted their original matrix and clast composition.

Clast-dominated tills deposited by Late Wisconsinan glaciers of short duration are characterized by basal transport less than 1 km. Ablation facies were formed during marginal stagnation by upward shearing of debris and down-wasting. The clast composition, texture and apparent dispersal characteristics of these tills were modified by inheritance from older tills in addition to being controlled by the dynamics of the younger till-forming event.

Quantitative parameters describing clast transport, such as renewal distance and half distance, are best applied when one generation, direction and mode of glacial transport can be assumed. Tills in Nova Scotia were formed and/or reworked by ice sheets of different dynamics and duration. Clast transport cannot generally be modelled using these parameters without detailed knowledge of the complete stratigraphic package, the mode and direction of transport, and the mixing relationships between different tills.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989
2 Poster presentation, 1990 CANQUA/AMQUA JOINT MEETING, Waterloo, Ontario

CAPE BRETON HIGHLANDS MAPPING PROJECT[1]

R. J. Horne

Geological mapping (1:10 000 scale) of the west-central Cape Breton Highlands (northwest portion of NTS map sheet 11K/7) indicates that the area is underlain by a NNE-trending belt of foliated metamorphic and granitoid rocks that have been intruded by unfoliated granitoid rocks.

METAMORPHIC ROCKS

Pelitic garnet-bearing schist (Dauphinee Brook schist) and fine- to coarse-grained amphibolite (George Brook amphibolite) occur in the northeast portion of the map area. A wide, NNW-trending mylonite zone occurs within the schist unit, locally defining the contact with an unfoliated granite. A well developed, southward-dipping stretching lineation within the mylonite is consistent with the mineral lineation in the surrounding schist and amphibolite.

A foliated and variably banded gneiss (Belle Cote Road gneiss), including minor amounts of amphibolite occurring as distinct concordant bands, underlies much of the map area. This unit has a variable mineral composition and is divisible into predominantly felsic and predominantly mafic areas. The foliation is folded and kinked throughout this unit. The origin of this unit is unknown. A wide muscovite - pyrite ± kyanite alteration zone developed along the rock fabric occurs on Cape Clear Road and a narrow, silicified pyrite-bearing zone was observed on the upper part of First Forks Brook.

FOLIATED GRANITOID ROCKS

A distinct, pink-red, moderately- to well-foliated augen granite unit (Taylors Barren Pluton) intrudes the Belle Cote Road gneiss and forms a linear body traversing the core of the map area. The contact between this unit and the Belle Cote Road gneiss is complex, consisting of a zone of interbanded augen granite and gneiss resulting from the development of a foliation common to both units. Locally, brittle cataclastic zones separate the Taylors Barren Pluton and the Belle Cote Road gneiss. Several small unfoliated to locally moderately foliated, medium grained, equigranular granitic intrusions, which may be genetically associated with the Taylors Barren Pluton, suggest the later stages of intrusion occurred near the end of the foliation-forming event. The foliation is folded and kinked throughout this unit.

UNFOLIATED GRANITOID ROCKS

Unfoliated granitoids include the medium- to coarse-grained, rapakivi textured Margaree Pluton (biotite-hornblende monzogranite) underlying the northwestern portion of the map area and the medium- to coarse-grained, megacrystic West Branch North River Pluton (biotite granodiorite) exposed in the southeast corner of the map area. A brittle cataclastic fault zone locally defines the boundary between the Margaree Pluton and the Taylors Barren Pluton.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

LATE PROTEROZOIC TECTONIC MODEL FOR THE AVALON TERRANE IN MARITIME CANADA[1]

J. D. Keppie and J. Dostal[2]

The Avalon Terrane in Maritime Canada extends from Cape Breton Island through northern Nova Scotia (Antigonish and Cobequid Highlands) to southern New Brunswick. The terrane contains abundant Late Proterozoic volcanic rocks (~ 600-650 Ma) mostly of bimodal nature. The geochemistry of volcanic rocks of southern Cape Breton Island and southern New Brunswick indicates that they were erupted in a volcanic arc environment. In both regions, the rocks display a remarkably similar compositional zonation which resembles the across-arc variations observed in modern volcanic arcs. The progressive compositional changes, which include a transition from island arc tholeiites along the coasts to calc-alkaline rocks inland, are probably due to a northwest-dipping subduction zone with a trench located to the southeast. On the other hand, in the Antigonish and Cobequid Highlands, calc-alkaline and continental tholeiitic volcanic rocks are interbedded and overlain by turbidites that have probably been deposited in a back-arc or intra-arc environment. The superimposed positive gravity and magnetic Collector Anomaly is inferred to represent Late Proterozoic ophiolitic remnants preserved by incomplete suturing along a Late Proterozoic plate boundary. Thus, the present geographic distribution of these rocks is interpreted in terms of a tectonic model involving one subduction zone offset by a Late Proterozoic transform fault located approximately along the Minas Fault.

1 Partially funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989

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GEOCHEMICAL ORIENTATION SURVEY AT THE YAVA Pb DEPOSIT, EASTERN CAPE BRETON ISLAND: A PROGRESS REPORT[1]

M. A. MacDonald, F. J. Boner and P. A. Lombard

A prerequisite for regional geochemical surveys is establishment of the typical geochemical response of mineral occurrences in the specific physiographic region(s) to be sampled. This is achieved through detailed orientation studies employing various sampling and analytical techniques. Several orientation surveys centred on known occurrences in different metallogenic environments throughout Nova Scotia will be conducted as part of the current Canada - Nova Scotia Cooperation Agreement on Mineral Development. Sample collection for the first study was completed during the 1990 field season. The survey focused on the Yava Pb deposit in the Salmon River Basin of eastern Cape Breton Island. Mineralization consists of disseminated galena within the basal 17 m of the grey sandstone member of the Silvermine Formation. The Yava deposit has several characteristics that make it ideal for detailed geochemical study: (1) the geological setting of the deposit is clearly defined; (2) extensive development-related diamond-drilling provides excellent control on the location of subcropping ore horizons; (3) ore removed during previous mining activities (1979-1981) was milled approximately 10 km away at Lake Enon, therefore contamination is presumably minimal; and (4) the glacial geology and physiography are relatively simple in comparison to the complex, karst-dominated terrains near other Carboniferous polymetallic deposits (e.g. Gays River, Walton).

The study began with a series of three overburden boreholes drilled in and adjacent to a drumlin located directly down-ice (NE) from the subcrop of the east ore zone. The purpose of drilling was to obtain fundamental information about the glacial stratigraphy before designing a sampling grid. A conventional diamond-drill with a triple-tube core barrel was used to maximize core recovery. Drilling indicated the area is mantled by a loose sandy till ($\leq$9 m), whereas the drumlin is cored by a highly compacted clayey lodgment till. The deepest hole (30 m) was located at the crest of the drumlin. Clasts from the upper 9 m are dominantly rhyolite porphyry (>90%) with minor sandstone, whereas the clasts from 9-30 m are dominantly sandstone (>90%) with minor zones containing up to 50% rhyolite. Virtually no matrix was recovered from the sandy upper unit but a complete core was obtained in the lower, clay-rich till.

Subsequent to overburden drilling a sampling grid measuring 2 x 2 km and consisting of 64 sites on 250 m centres was established over the deposit's east zone. Specimens collected at each site included: (1) approximately 3-5 kg of clasts (>1 cm) and approximately 5 kg of matrix (<1 cm) from unweathered till (0.8-1.2 m depth), (2) 5-7 years growth on balsam fir and/or black spruce, depending on species availability, and (3) organic humus (A_1 horizon). A slow-moving, often stagnant stream that traverses the grid was sampled at 250 m spacing for approximately 1.8 km. Several rock specimens were collected for lithogeochemical analysis including mineralized and unmineralized Silvermine Formation sandstone and rhyolite porphyry from the Loch Lomond Plutonic Complex. At the time of submission of this report, specimens had been submitted for sample preparation but no analytical data were available.

The objectives of this project include: (1) determination of the complete geochemical fingerprint of the Yava deposit; (2) evaluation of the relative effectiveness of the stream, till and biogeochemical sampling media. This will include cost effectiveness, ease of sampling, availability of sample medium in specific terrain and strength of anomaly/background contrast; and (3) establishment of the optimal geochemical technique for mineral exploration in the eastern Cape Breton lowland physiographic region, particularily in the Salmon River Basin.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Corporation Agreement on Mineral Development 1990-1992

CONTINUING DATA ANALYSIS OF BULK STREAM SEDIMENT SAMPLES FROM NORTHERN NOVA SCOTIA[1]

R. F. Mills

BACKGROUND

A two year regional geochemical stream sediment and water survey was carried out across northern mainland Nova Scotia and Cape Breton Island in 1986 and 1987 (Mills, 1990). Approximately 3300 stream sediment samples, including duplicates, were analyzed for 30 elements in the coarse (-60 +230 mesh) heavy mineral separate fraction by induced neutron activation analysis, and for 16 elements in the fine (-230 mesh) fraction by directly coupled plasma atomic emission spectroscopy. Some of the original gold analyses were supplemented with later repeat fire assay analyses for gold. Stream waters were analyzed for U by fluorimetry and for F by specific ion electrode methods. Conductivity and pH measurements were also made of the stream waters and their possible relation to terrain and/or acid rain. Primary objectives were to provide a database for exploration activity in the northern part of the Province utilizing a technique specifically designed to retain gold. The data are currently being prepared to be included as part of the regional Nova Scotia Geochemical Atlas database.

DATA PRESENTATION

The database consists of several parts. These are included the analyses files from the stream sediment heavy mineral concentrates and fine fraction analyses file (for 1986 and 1987), the stream water analyses files, the 1986 fire assay analyses file and the text file including sample site information. Sample locations for the fine fraction gold analyses were digitized and presented in three 1:250 000 scale map sheets. Data were organized into either Map No. 1, the Cumberland, Colchester and Pictou Counties Sheet (Cobequid Highlands and surrounding area), Map No. 2, the Antigonish, Colchester, Guysborough, and Pictou Counties Sheet (Antigonish Highlands and surrounding area), or Map No. 3 covering Cape Breton Island (Mills, 1989).

CONTINUING (CURRENT) DATA REDUCTION

These files have been merged with Universal Transverse Mercator location coordinates so that the datasets may be layered over one another to make relative comparisons and correlations. Several computer programs will be used in the reduction of these data, which will continue as they are compared to older and newer data over the coming years. The immediate objective is to ready the dataset for inclusion in the regional geochemical atlas database. The contour layering software is a sophisticated geographic information system package called SPANS and has the ability to draw correlations in two dimensions, giving workers a powerful tool with which to delineate multi-element anomalies.

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Mills, R. F. 1990: Gold anomalies in -230 mesh fraction of bulk stream sediment samples from northern Nova Scotia; *in* Report of Activities 1989, Part B, ed. D. R. MacDonald; Nova Scotia Department of Mines and Energy, Report 90-1, p. 41-47.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989

STRUCTURAL AND LITHOLOGIC CONTROLS OF METASEDIMENT-HOSTED TIN, BASE METAL AND PRECIOUS METAL MINERALIZATION, SOUTHWEST NOVA SCOTIA[1]

G. A. O'Reilly and D. J. Kontak

Numerous tin, base metal and precious metal deposits are hosted by Cambrian to Ordovician Meguma Group metasedimentary rocks and Devono-Carboniferous peraluminous granitic rocks in southwest Nova Scotia. The deposits define a northeast-trending linear belt originating within the South Mountain Batholith east of the East Kemptville tin mine and extending outward into the metasedimentary rocks for some 65 km to Wedgeport, Yarmouth County. While some of the deposits have been known for over a century, others were discovered during exploration since the late 1970s. Geological investigations by the Nova Scotia Department of Mines and Energy began at granite-hosted deposits in this area under the previous federal-provincial Mineral Development Agreement (1984-89) and are now continuing at several of the metasediment-hosted sites under the current Canada - Nova Scotia Cooperation Agreement on Mineral Development.

The linear belt of mineral deposits is referred to as the Southwest Nova Scotia Tin Domain and a variety of deposit types and elemental associations are represented. For example, deposits such as Duck Pond (Sn-Cu-Zn), Pearl Lake (Sn-Cu) and Gardners Meadow Brook (Sn-Cu) are hosted within the Goldenville Formation - Halifax Formation transition zone where mineralization is associated with pervasive fracturing, Fe- and Mn-rich lithologies and chlorite-garnet alteration. At the Fanning Lake and Kempt Back Lake prospects, polymetallic sulphides and precious metals occur within strongly sheared and fractured wacke and argillite that have been silicified and sericitized. At the past-producing Kemptville and Carleton gold mines, native gold occurs in both stratabound and discordant quartz veins in highly sheared and hydrothermally altered wall rocks. The Dominique Sn-Cu-Pb-Zn-Ag deposit occurs in strongly chloritized and carbonitized shear zones in exo-contact argillite of the Wedgeport Pluton. Granite-hosted mineralization is represented by the East Kemptville tin deposit and the Kempt Snare Lake W-Pb-Zn-Ag prospect.

During the past year investigations were concentrated along a zone characterized by intense shearing and extensive hydrothermal alteration that links the past-producing Kemptville gold mine, the Kempt Back Lake gold prospect and the former Carleton gold mine. Detailed studies along the northern contact of the South Mountain Batholith indicate that deposits such as Duck Pond and Pearl Lake may also have a genetic relationship to the widespread shearing recognized throughout this region, even though some of the mineralization is also lithologically controlled. In addition to studies on the metasediment-hosted mineralization, studies have commenced on a 851 m deep Nova Scotia Department of Mines and Energy diamond-drill hole collared in the Baby Zone tin deposit located immediately adjacent to (i.e. southwest of) the East Kemptville tin mine.

The Geological Survey of Canada has recently released the results of airborne geophysical surveys that cover much of southwest Nova Scotia. The vertical gradient data from this release are proving to be invaluable for defining the regional extent of the shear and fault systems that traverse this region. Since many of the mineralized sites show a consistent relationship to these shear systems, interpretation of the geophysical maps may provide insight into locating as yet undiscovered mineralization.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989 and the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

REGIONAL GEOCHEMICAL SURVEYS IN NOVA SCOTIA (1957 TO 1989)[1]

P. J. Rogers and P. A. Lombard

Since 1957 the Nova Scotia Department of Mines and Energy and Geological Survey of Canada have conducted 13 regional geochemical surveys in the various physiographic regions of the Province. Most of these surveys were funded by cooperative agreements between the federal and provincial governments to stimulate economic activity through increased mineral exploration activity. Table 1 summarizes the surveys by sample media, region, sampling density and date. Each survey type is also given a classification based on sampling strategy as follows: Stage 1: Chemical weathering-partial extraction, Stage 2: Mechanical weathering and Stage 3: Stages 1 and 2 plus all major elements.

The details of each geochemical survey are in preparation and preliminary maps of the Geochemical Atlas may be viewed at the Open House.

Table 1. Summary of geochemical surveys and sampling densities.

SAMPLE MEDIUM	REGION	AREA (KM^2)	NO. OF SAMPLES (N)	SAMPLE DENSITY (N/KM^2)
1. LAKE SEDIMENTS				
STAGE 1				
1977/78	MZ	26991.63	3416	7.90
1983	NNS	3084.88	414	7.45
STAGE 2				
1985	MZ	22935.98	2951	7.77
2. STREAM SEDIMENTS				
STAGE 1				
1957/8	MZ+NNS		8800	4.84
STAGE 2				
1971/73	COBS	2100.49	5870	2.80
1974/75	ANT	2201.50	6870	3.12
1973/78	CBI	11965.80	14450	1.20
1982/83	NNS	19278.26	4500	4.28
STAGE 3				
1986/87	NNS	22528.34	3000	7.51
3. TILLS				
1977/82	MZ	30232.46	1120	26.99
1982/86	NNS	12360.37	941	13.12
1984/89	SMB	10000.00	1700	5.88
4. VEGETATION				
1987/SB	MZ	5000.00	593	46.73
1987/BF	MZ	5000.00	593	8.43

Abbreviations: ANT = Antigonish Highlands, CBI = Cape Breton Island, COBS = Cobequid Highlands, MZ = Meguma Zone, NNS = northern Nova Scotia, SMB = South Mountain Batholith, BF = balsam fir, SB = spruce bark.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989

GEOLOGY MAPS OF THE CUMBERLAND BASIN, COLCHESTER, CUMBERLAND AND PICTOU COUNTIES, NOVA SCOTIA[1]

R. J. Ryan, R. C. Boehner, J. H. Calder, A. Deal[2] and D. C. Carter[3]

A set of four new geology maps of the Cumberland Basin in northern Nova Scotia has been published as the final map product of the recently-completed Cumberland Basin Project (NSDME Maps 90-11, -12, -13 and -14). These four-colour, 1:50 000 scale maps update an older, incomplete selection of maps produced between the late 1800s and the early 1950s by the Geological Survey of Canada. Previously unavailable seismic and deep exploration drillhole data have contributed to an improved understanding of the stratigraphy, sedimentology, structure, paleontology, and mineral and energy resource potential.

The Cumberland Basin is the largest (3500 km^2) and deepest (7 km+) onshore Carboniferous Basin in Nova Scotia and has had a long production history of coal, salt, gypsum, limestone, copper and building stone. Currently, salt production facilities at Pugwash (Canadian Salt Company Limited) and at Nappan (Sifto Canada Inc.) are major contributors to the local and provincial mineral economy. A series of three detailed geology maps of the Pugwash Mine by D. C. Carter have also recently been published (NSDME Maps 90-1, -2, -3). These maps are a unique documentation of the internal geology of an extremely complex evaporite diapir and will be very useful in continuing mine development.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989
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THE THERMAL AND METALLOGENIC EVOLUTION OF THE MARITIMES BASIN: EVIDENCE FROM THE CUMBERLAND BASIN OF NOVA SCOTIA[1]

R. J. Ryan, A. Grist[2], M. Zentilli[2] and R. Donelick[2]

The objective of this study is to quantify and interpret the thermal and metallogenic history of the Cumberland Basin, and the greater Maritimes Basin, on the basis of integrated geological, mineralogical and paleothermometric data, including fission-track thermochronology. In particular, it addresses the amount of sedimentary cover removed from the basin by erosion and the timing of the erosion events. The present distribution of the Maritimes Basin is only an erosional remnant of a much larger Permian to Carboniferous basin of deposition. Interpretation of the thermal imprint on the extant sediments and contained organic matter may be the only method of addressing the missing sedimentary cover. A reconstruction of the basin prior to erosion is essential if we are to better understand the thermal controls on metallogenesis within the basin. The preliminary fission-track age date results indicate that the period of maximum burial for the sedimentary rocks of the basin was at 290-250 Ma, a rapid basin-wide erosion took place from 240 to 200 Ma, and continued slower erosion has taken place since that time. The results clearly show that there has been no significant Mesozoic sedimentation over the Maritimes Basin and therefore the Mesozoic sedimentation must have been restricted to the Bay of Fundy region. These preliminary results will be used to model basin-fluid heat flux models in an attempt to constrain models previously proposed for mineralization in the Maritimes Basin.

1 Funded by the Canada - Nova Scotia Mineral Development Agreement 1984-1989, the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992, and an Energy, Mines and Resources Canada Grant to Dalhousie University

2 Department of Geology, Dalhousie University, Halifax, Nova Scotia

GOLD-ANTIMONY ASSOCIATION AT WEST GORE, NOVA SCOTIA[1]

P. K. Smith and D. J. Kontak

Mineralization at West Gore is mainly confined to late stage cross-cutting quartz veins with subordinate amounts of bedding-parallel veins and quartz breccia. Ore mineralogy consists mainly of native antimony, stibnite and minor disseminated gold. Gangue mineralogy consists essentially of fine grained euhedral quartz with associated coarse grained quartz forming rosette-type structures with minor amounts of carbonate. Trace amounts of chlorite and sericite occur locally throughout the veins. Because the association and physical setting of gold are different from those of other Meguma Group gold districts, further description is warranted.

Moss textured gold or "Rheingold" shows an intimate association with the antimony minerals, although fine grained gold also occurs as disseminations through the host quartz in concentrations up to 3 oz./ton. Disseminated sulphides in the sericitized wall rock adjacent to vein quartz is rare. Arsenopyrite, generally as euhedral crystals, is present at West Gore but is not abundant as in most other Meguma gold districts. Intergrowth textures of antimony minerals, gold and euhedral quartz crystals strongly suggest contemporaneous crystallization. Although there is moderately strong shear deformation of the sericitic host rock, the well preserved, delicate crystal habit of gold, antimony minerals and small quartz crystals suggests late-stage mineralization.

An alloy of $AuCu_3$ is observed in close association with gold-antimony-arsenopyrite mineralization but is not common. Preliminary microprobe results suggest anomalous concentrations of antimony (Sb) are present in arsenopyrite crystals associated with some gold districts.

Preliminary investigations of this mineralization suggest that it occurs in a high level environment and may in part represent the root structure of an epithermal deposit, which may have passed through overlying Carboniferous stratigraphy.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989

MICRON GOLD IN MEGUMA GROUP GOLD DEPOSITS, NOVA SCOTIA[1]

P. K. Smith and D. J. Kontak

Meguma Group lode gold deposits have historically been known for their coarse, nuggety gold, rendering mining difficult. The resurgence of gold mining during the early to mid 1980s saw gold extracted by gravity separation. In all cases, these operations have ceased for a variety of reasons, including suspected low grade ore and difficulty in following ore zones. A new outlook for the viability of economic mineralization for many of these deposits, based on recent geological and petrographic investigations, is warranted.

Micron-sized gold (<100μ) represents a significant portion of the total gold present in all Meguma Group hosted gold deposits, varying from about 10% to 50%. These gold grains have been observed as small as 0.5μ where they occur as either isolated grains or along fluid inclusion planes, commonly surrounded by formation fluids. This fine grained gold occurs in numerous sites within three dominant settings: (1) within numerous quartz vein types (in quartz and other silicates), (2) in host rock adjacent to quartz veins and (3) in thick argillite sequences devoid of significant vein material. In all three of these settings gold is closely associated with sulphide minerals, particularly arsenopyrite and pyrrhotite, where it may occur as attached grains to the surface of sulphides, in grain contact with other sulphides that occur as small inclusions in larger sulphide grains, as fracture fillings throughout sulphide crystals, and as grains enclosed along discrete composition bands, particularly in arsenopyrite crystals where they form alteration halos around high grade ore shoots.

Geochemistry reveals that there is a distinct element association between micron gold and Bi-Sb-Pb-W$\pm$Te$\pm$Cu in vein-type mineralization throughout the Meguma Group. Petrographic studies confirm the presence of associated mineralogy, including native bismuth in grain contact with gold along fluid inclusion planes.

Where micron-sized gold constitutes a high percentage of the total gold content of a particular deposit it becomes a significant economic factor, especially where gravity is the only method of extraction. Laboratory tests have revealed that much of the fine grained gold from deposits in the Meguma Group is not recovered using currently utilized equipment. However, cyanide leach extraction on this material has proved very effective on the material tested so far. Furthermore, our tests have revealed that conventional fire assay tests on whole-rock samples may be misleading if total sulphide content is high.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement 1984-1989

ALTERATION AND GOLD MINERALIZATION IN THE CAPE BRETON HIGHLANDS, NOVA SCOTIA

P. K. Smith, D. M. Slauenwhite[1] and G. A. O'Reilly

Auriferous quartz boulders were discovered in the central Cape Breton Highlands by INCO/SCOMINEX during the summer of 1986. Subsequent exploration trenching and drilling have resulted in the recognition of numerous bedrock occurrences of high grade gold mineralization associated primarily with variably deformed quartz veins.

Strata hosting these auriferous veins have been divided into three distinctive rock units based primarily on dominant lithology. These include: 1. Western Unit: consisting of intercalated metasedimentary and metavolcanic lithologies, 2. Central Unit: consisting of paragneiss and orthogneiss with later diorite, granodiorite and granitic intrusions, and coarse grained mafic dykes, and 3. Eastern Unit: consisting of alternating quartzo-feldspathic metasediments and micaceous schists with lesser amounts of marble, calc-silicate and quartzite. Within these strata, lower greenschist facies metamorphism is attained in the south while middle amphibolite facies is observed in the north.

Pervasive epidote alteration is widespread throughout the region and affects all rock types. More localized alteration zones containing chlorite, carbonate and minor pyrite are fault and fracture controlled. Although examples of these alterations are anomalous in gold (i.e. >100 ppb), none to date have been found to be spatially associated with economic concentrations of gold. Adjacent to some high grade auriferous quartz veins, sericite, chlorite, hematite and biotite form distinct hydrothermal alteration selvages. In all cases, the mineralization and alteration are restricted to sheared and fractured zones; thus, these zones become good exploration targets. Whole rock geochemistry indicates a change in major and some trace elements across these alteration fringes.

Native gold occurs primarily in hematite and pyrite selvages within discontinuous quartz veins which may occur in en-echelon arrays. Individual veins have widths of up to several metres with strike lengths of up to 72 m. Minor amounts of gangue minerals include calcite, chlorite, muscovite, sericite, epidote, plagioclase and amphibole. Petrographic examination of mineralized samples from several sites throughout the area shows fine grained (<100μ) gold strongly associated with the abundance of oxidized pyrite and to a lesser extent with fresh pyrite, galena and colloform-textured hematite. Anomalous gold concentrations are also present in stockwork veins structurally below larger auriferous veins (eg. 6B) and deformed veinlets within an intensely sheared mafic volcanic unit at the Northeast Shear. Microprobe analyses show variable silver content in individual gold grains ranges from 5 - 22 wt. %, distinctly different from the uniform silver content in Meguma Group gold.

Although data for genetic modelling is incomplete, the widespread distribution of mineralization and extensive alteration demonstrates encouraging economic potential for this region.

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ACADIA UNIVERSITY, DEPARTMENT OF GEOLOGY

J. A. Colwell, Head

Acadia University is located in Wolfville, Nova Scotia, in the eastern Annapolis Valley about 100 km northwest of Halifax. The Geology Department consists of 7 full-time professors, 2 part-time lecturers and 1 demonstrator. We have 23 undergraduate majors, 6 graduate students and one postdoctoral fellow. The Geology Department emphasizes an integrated field and laboratory approach and offers instruction and research training leading to the four year degrees of Bachelor of Science and Bachelor of Science with Honours, and the Master of Science degree. Research funding mainly comes from faculty grants and contracts, which are held by most staff. Full-time graduate students also hold fellowships.

RESEARCH PROJECTS IN NOVA SCOTIA

S. M. Barr - regional mapping and petrologic studies of volcanic and granitoid rocks, Cape Breton Island.
B. W. Cameron - vertebrate and invertebrate paleontology and trace fossils of the Horton Bluff, Wolfville, Blomidon and Scots Bay formations.
J. A. Colwell - geology of the North Mountain Basalt.
D. W. A. McMullin (post doctoral fellow) - geological correlations between Nova Scotia and Newfoundland.
R. G. Moore - geological mapping in the Cogmagun River-Goshen areas, Hants Co.; biostratigraphy of the Windsor Group.
R. P. Raeside - regional mapping and tectonics of Cape Breton Island.
G. R. Stevens - interpretation of sidescan radar imagery of the Gaspereau Lake - Windsor area; meteor impact structure.
N. A. Van Wagoner - the Fourchu Group and associated granitoid rocks, Cape Breton Island; the Stirling sulphide deposit.
G. M. Yeo - sedimentology of the Cornwallis River estuary; Paleozoic ironstones of Nova Scotia.

THESES IN PROGRESS RELATED TO NOVA SCOTIA GEOLOGY

Sedimentology of the Lower Stellarton units, Pictou County, Nova Scotia (Luc Daigle - M.Sc.)
Sedimentology of the inner Cornwallis estuary (Alice Dickinson - B.Sc.,H.)
Petrology and economic potential of gabbroic plutons in southeastern Cape Breton Island (Anastassios Grammatikopoulos - M.Sc.)
Granitoid rocks of the Marble Mountain area, Cape Breton Island (Mario Justino - M.Sc.)
Quaternary stratigraphy of the Guzzle area (Nadine McDow - B.Sc.,H.)
Geology of the Blair River Complex, Cape Breton Island (Brent Miller - Ph.D. with Dalhousie)
Stratigraphy, structure and metamorphism of the Cape North and Money Point groups, Cape Breton Island (Adoon Wunapeera - M.Sc.)
Primary cooling structures in the North Mountain Basalt (S. Saveur - B.Sc.,H.)

DALHOUSIE UNIVERSITY: DEPARTMENT OF GEOLOGY STUDENT RESEARCH IN NOVA SCOTIA

R. A. Jamieson, Graduate Co-Ordinator

INTRODUCTION

Dalhousie University in Halifax is well situated and well equipped for research in a range of Earth Science disciplines. The department includes 15 full-time faculty members and 6 university technicians, with 16 Ph.D., 16 M.Sc. and 7 B.Sc. honours students (final year) registered in 1990-91.

The department's main strengths are Marine Geology and Appalachian Geology, with many faculty members and their students involved in research in Nova Scotia or its adjacent continental margin. Research is funded largely through the Natural Sciences and Engineering Research Council (NSERC), other government agencies, and contracts; most graduate students hold scholarships or fellowships paid from University and/or research funds.

Research equipment includes a JEOL Superprobe, now being upgraded with an image analysis system (run as a regional facility), conventional and laserprobe $^{40}Ar/^{39}Ar$ dating facilities, a fission track lab (the only university facility of its kind in Canada), X-ray diffraction, atomic absorption and volatile analysis equipment, a high pressure seismic velocity lab, a stable isotope lab, a paleomagnetism lab, and a wide range of geophysical, sedimentological, micropaleontological, computing, petrographic, sample preparation, and photographic equipment. In addition, department members have access to the regional X-ray isotope facility (AURIF) now being set up at Memorial University of Newfoundland.

RECENTLY COMPLETED THESIS RESEARCH IN NOVA SCOTIA

J. Jennings (B.Sc.) 1989. A geophysical study of the Liscomb Satellite Pluton, central Nova Scotia.
K. McKillop (B.Sc.) 1989. Fission track study of the Jubilee deposit, Cape Breton Island, Nova Scotia.
A. Grist (M.Sc.) 1989. Provenance and thermal history of detrital sandstones of the Scotia Basin, offshore Nova Scotia, using the apatite fission track and $^{40}Ar/^{39}Ar$ methods.
K. Billard (B.Sc.) 1990. Geophysical modelling of the LaHave Clay and Emerald Silt formations, LaHave Basin.
H. McLaughlin (B.Sc.) 1990. Thermobarometry of the metasedimentary enclaves in the Ten Mile Lake intrusion, Liscomb, Nova Scotia.
B. Laidler (M.Sc.) 1990. Distribution of foraminifera and thecamoebans in sediments of Porters Lake, Halifax County.
T. Martel (Ph.D.) 1990. Stratigraphy, fluviolacustrine sedimentology and cyclicity of the Late Devonian/Early Carboniferous Horton Bluff Formation, Nova Scotia, Canada.

MINERAL RESOURCES TECHNOLOGY AT THE UNIVERSITY COLLEGE OF CAPE BRETON: A CO-OP EDUCATION PROGRAM

H. R. Oldale

In September 1987, the Mineral Technology program at the University College of Cape Breton (U.C.C.B.) was converted to a three-year co-operative education format. The program includes five academic semesters and three four-month job placements leading to a Diploma in Mineral Resources Technology* with a co-operative endorsement. The program trains students in geology, mineral exploration, surface and underground mining, mineral processing and analytical chemical methods. Further information is available from the Co-operative Education office (902) 539-5300, ext. 129, or the Mineral Department (902) 539-5300, ext. 191.

The curriculum objective of the program, since its inception in 1968, has been to provide a strong fundamental background for technical employment in the exploration, production and processing phases of the minerals industry. Some main features of the curriculum include: (1) a thorough grass roots field exploration project, (2) a complete mine feasibility project, (3) visits to mining operations throughout the Atlantic Provinces and (4) extensive use of computer applications in all courses. Since the first class graduated in 1970, some 135 students have obtained their diplomas and are employed throughout the country in all aspects of the mining and petroleum industries. Many of the earlier graduates now occupy senior technical and management positions.

Initial employment statistics over the past 20 years (within three months of graduation) show approximately 20% of the graduates are employed in each of the exploration, mining and mineral processing phases of the mineral resources industry. Analytical laboratory work employs 10%, whereas another 10% are employed in mining-related occupations. Some 15% further their studies and the remaining 5% obtain employment in jobs unrelated to the minerals industry.

An industry advisory committee, meeting on an annual or bi-annual basis, serves to keep the program current and up-to-date. The committee comprises some 16 senior personnel representing industry, government and educational institutions throughout Nova Scotia and New Brunswick.

FACULTY

F. M. Isenor, Dipl. T., B.Sc., a mining geologist, joined the department in 1981. He is a graduate of the Mineral Technology program and has had seven years industry experience in exploration work and coal mining geology. His teaching responsibilities include geology, surveying and assaying.

C. P. Nicholson, Dipl. T., is a graduate of the Mineral Technology program. He joined the faculty in 1981 after eight years experience in local mining and construction. His teaching duties include laboratory instruction in geology, mining, surveying, computers and exploration, in addition to laboratory maintenance and purchasing responsibilities.

H. R. Oldale, M.Sc., B. Ed., P. Eng., the senior member, joined the Department in December 1967 to set up the program prior to it opening in September 1968. Before 1967 he had spent 10 years in geology, mine engineering, development and exploration management. He presently teaches geology and exploration methods.

H. E. Slaunwhite, B. Eng., B. Ed., P.Eng., a mining engineer, has taught in the program since 1969 after working 10 years in mining operations and industrial engineering. He presently teaches mineral processing, mining, computer applications and surveying.

* Name changed from Mineral Technology to Mineral Resources Technology in 1990

SAINT MARY'S UNIVERSITY: GEOLOGY DEPARTMENT RESEARCH

G. Pe-Piper, Chairperson

The Geology Department of Saint Mary's University offers a complete undergraduate program leading to geology major and honours degrees. Within the department, courses are offered in most geological disciplines supplemented by cross-listed courses given by other departments, such as geomorphology and analytical chemistry for chemists and geologists. Courses offered by the department also support the degree programs of departments such as Geography, Chemistry and Anthropology. This year, along with other science departments, the Geology Department will be implementing a Co-operative Education Program, in which students work in geology-related jobs as part of their degree requirements.

The department consists of five full-time and three part-time faculty members, one technician and a secretary. We also have two adjunct professors, from the Geological Survey of Canada and the Nova Scotia Department of Mines and Energy. The department also houses the Regional Geochemical Centre with two full-time technicians. This centre consists of X-ray fluorescence and Instrumental Neutron Activation Analysis facilities that the department operates on behalf of a consortium of five Maritime universities.

The department maintains a varied research program. Research is funded largely through the Natural Sciences and Engineering Research Council (NSERC), other government agencies and contracts.

FACULTY RESEARCH PROJECTS (HIGHLIGHTING RECENT WORK IN NOVA SCOTIA)

J. Dostal - igneous petrology; geochemistry (evolution of the Avalon Terrain in Maritime Canada during Late Proterozoic; geochemistry of felsic volcanic rocks of the Fourchu Group, Cape Breton Island; relationship between convection volatile movement, liquid immiscibility and cooling history in North Mountain basalts).
J. V. Owen - metamorphic petrology; structural geology (investigation of crystalline rocks in Eastern Canada; recent work centres on: 1 billion year old granites in Labrador; migmatitic rocks in western Quebec; crustal xenoliths from the Dunnage zone, Newfoundland).
G. Pe-Piper - igneous petrology; mineralogy; geochemistry (volcanic evolution and hydrothermal alteration of the Fountain Lake Group, western Cobequids; petrogenesis, geochemistry and mineralization of the A-type granites of Cobequids; plutonic and other basement rocks from the Scotian Shelf and their regional significance).
Q. A. Siddiqui - micropaleontology; biostratigraphy (present work centres on: some Cretaceous deep water ostracods obtained by the Ocean Drilling Program in the Weddell Sea, Antarctica, and establishing a data base for ostracods from cold marine and marginal marine waters of the eastern Canadian Arctic).
J. W. F. Waldron - structural geology; sedimentology (present work centres on: stratigraphy and sedimentation of the Meguma Group, including the description of probable early Middle Cambrian fossil debris from Goldenville Formation in Mahone Bay; Carboniferous sediments and structure adjacent to the Cobequid-Chedabucto fault zone, Nova Scotia; Paleozoic tectonic history of the west Newfoundland Appalachians, with emphasis on Acadian thrusting and its effect on Taconian structure and sedimentary basins).

B.SC. THESES IN PROGRESS, 1990-91

R. E. Corney - Mid-Ordovician syntectonic sediments of the Goose Tickle Group, Victors Brook area, Port au Port Peninsula, Newfoundland.
S. Guimond - Carbonates at the Cumberland - Pictou boundary north of the Stellarton Graben, Nova Scotia.
J. Nearing - Carboniferous hydrothermal events in the western Cobequids.
H. Pancura - Hydrothermal alteration and volcanic evolution of the Fountain Lake Group, Cape Chignecto, western Cobequids.
J. Selway - Detailed geology, petrology and geochemistry of the Pleasant Hills Pluton, eastern Cobequids.

COMPLEX VOLCANIC HISTORY CONFIRMED FOR SOUTHEASTERN CAPE BRETON ISLAND[1]

S. M. Barr[2], M. L. Bevier[3], A. S. Macdonald[2] and C. E. White[2]

Volcanic and sedimentary rocks in southeastern Cape Breton Island occur in the Coastal, Stirling, East Bay Hills, Coxheath Hills and Sporting Mountain belts, separated by Cambrian and younger strata. As part of an on-going study of field relations, stratigraphy, tectonic history and metallogenic environment of these rocks, we report here preliminary results of U-Pb dating. These are the first reliable dates from volcanic rocks of southeastern Cape Breton Island and they show that volcanism occurred over a period of at least 100 Ma.

The Coastal belt consists dominantly of crystal and lithic-crystal tuff of intermediate (dacitic) composition. A sample from a feldspar crystal-tuff unit at Kennington Cove yielded three zircon fractions, one concordant and the other two plotting slightly below concordia. They indicate an age of 574 $\pm$ 1 Ma.

The Stirling belt is dominated by intermediate to mafic lithic tuff and wacke-siltstone units. A sample of porphyritic quartz-feldspar rhyolite/rhyodacite from the vicinity of the Mindamar Zn-Pb-Cu-Ag-Au deposit contained a single morphological population of zircons. One fraction was concordant and yielded a $^{206}Pb/^{238}U$ age of 676 $\pm$ 1 Ma; hence, volcanic units of the Stirling belt are significantly older than the ca. 620 Ma old granodiorite of the Chisholm Brook Suite that intruded the belt.

The East Bay Hills consist mainly of intermediate to felsic crystal and crystal-lithic tuff and less abundant flows, ranging in composition from basalt to rhyolite. At the northeastern end of the belt, rhyolitic flows occur in association with lapilli tuff and sedimentary rocks of the Main-a-Dieu sequence. A flow-banded rhyolite sample from this area produced three concordant zircon fractions which yielded ages of ca. 603, 635 and 660 Ma. Hence ca. 603 Ma is the maximum age of the rhyolite, showing that this volcanic-sedimentary sequence is younger than the dacitic and andesitic tuff sequence intruded by the ca. 625 Ma old Huntington Mountain Pluton farther south in the East Bay Hills.

These U-Pb data show that volcanic rocks in southeastern Cape Breton Island range in age at least from 574 Ma to 676 Ma, and hence should not be considered co-genetic. The Stirling belt may contain the oldest volcanic units.

1 Funded by the Geological Survey of Canada under the Canada - Nova Scotia Mineral Development Agreement 1984-1989
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CONTRIBUTIONS TO THE VERTEBRATE PALEONTOLOGY OF THE LATE TRIASSIC-EARLY JURASSIC FUNDY GROUP ALONG THE SCOTS BAY-CAPE BLOMIDON COAST[1]

B. Cameron[2], *D. Domanski*[3] *and J. R. Jones*[2]

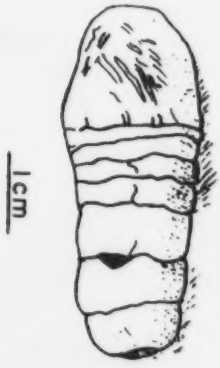
We are collaborating on the preparation and study of our separate and joint collections of rare vertebrate fossils from coastal exposures of the Fundy Group from near Baxters Harbour to Scots Bay and from Lower Blomidon to Kingsport, Nova Scotia. Our materials include skeletal elements, footprints and coprolites from the Late Triassic, fluvial-lacustrine Wolfville and Blomidon formations and the Early Jurassic, dominantly lacustrine, Scots Bay Formation. Invertebrate, plant and algal body fossils, and other trace fossils are also being studied.

From the upper Wolfville Formation, we have identified the following vertebrate footprints: *Atreipus acadianus* (ornithischian dinosaur footprints), *Rhynchosauroides* cf. *R. brunswicki* (sphenodontid-like, tiny reptile footprints), the large *Brachychirotherium* cf. *B. parvum* (aetosaur? archosaur), and ?*Chirotherium* cf. *C. lulli* (rauisuchid? archosaur).

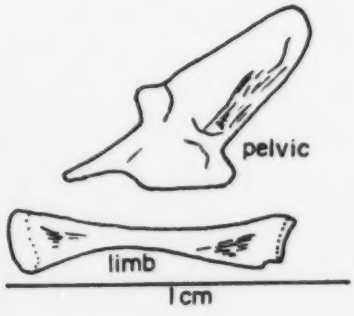
From the Blomidon Formation, we have collected isolated fish scales and bones at several localities as well as several partial fish from a single bed. These fish have not been identified yet. This fish-bearing bed overlies playa-like shale containing ostracodes, conchostracans, unidentified fish remains and some invertebrate trace fossils.

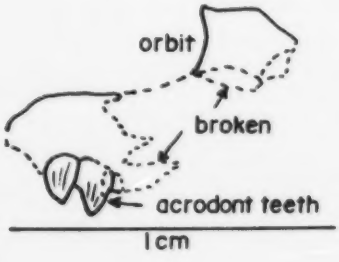
From the Scots Bay Formation, we have identified sphenodontid pelvic and leg bones and a partial skull, the dinosaur footprints *Anchisauripus* and *Eubrontes*, freshwater shark (?hybodont) coprolites containing fish scales and bones, and nearly complete specimens of the holostean fish group *Semionotus tenuiceps*. These fossils are associated with charophytic algae, freshwater stromatolites, ferns, conifers, clams, snails and ostracodes.

Line drawings of some new Scots Bay Formation fossils:



Shark Coprolite





Sphenodontid Ilium, Leg Bone & Cheek Teeth

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ARCHEAN AND EARLY PROTEROZOIC DETRITAL ZIRCON IN PALEOZOIC SILICIC ROCKS OF CAPE BRETON ISLAND AND COBEQUID HIGHLANDS, NOVA SCOTIA: PRELIMINARY RESULTS[1]

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The subvolcanic Salmon River rhyolite porphyry of Cape Breton Island intrudes Cambrian redbeds and has yielded a ca. 368 Ma Rb-Sr date (Barr *et al.*, 1984). However, the porphyry contains only detrital zircon with no overgrowths. The rock is undersaturated in zirconium using the criteria of Watson and Harrison (1983). Only one zircon population is likely as the data points lie on a single discordia with an upper intercept of 2560 Ma. Zircon from the Cambrian redbed host rocks is being analyzed to see if the redbeds may be the source of zircon in the porphyry. A deeper source would be more significant, implying the existence of Archean basement at depth in this area.

A sample of Fountain Lake rhyolite, from the Cobequid Highlands, contained just a few grains of zircon, all with detrital morphology. The Rb-Sr date is 341±4 Ma (Pe Piper *et al.*, 1989). Only one analysis was possible, yielding a $^{207}Pb/^{206}Pb$ date of 2390 Ma. The upper intercept could be greater than this if the discordia has a positive lower intercept, as is the case for the Salmon River porphyry. The rhyolite has been resampled to better estimate the age and homogeneity of the zircon.

The data provide evidence of a Late-Archean or Early Proterozoic basement to the Avalon terrane in Nova Scotia.

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GEOCHRONOLOGY OF THE COBEQUID HIGHLANDS, NOVA SCOTIA: A REVIEW AND NEW U-Pb AGE DATES[1]

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The Cobequid Highlands of northern mainland Nova Scotia consist of Precambrian to early Carboniferous rocks (Donohoe and Wallace, 1982). Early K-Ar (e.g. Wanless *et al.*, 1972) and Rb-Sr (Gaudette *et al.*, 1984) studies aided important advances in the knowledge of the region's geological history (Donohoe and Wallace, 1985). Recent precise U-Pb age dates (Doig *et al.*, in prep. a,b) have resulted in a re-interpretation of the area's geological history. Some of the most important results include:
(1) A 734±2 Ma age for the gneiss on Economy River that intrudes the Gamble Brook Formation of the Bass River complex (Doig *et al.*, 1989). This confirms the antiquity of the Gamble Brook Formation relative to the Late Precambrian Avalonian orogenic cycle.
(2) A ca. 580-600 Ma age for the Great Village River Gneiss (Doig *et al.*, 1989) implies that the gneiss should be considered part of the Avalonian orogenic cycle rather than basement to the Avalon.
(3) Preliminary U-Pb data on Carboniferous plutons (Doig *et al.*, 1989) provide evidence that many of these plutons are ca. 360 Ma old rather than the wide range of ages indicated by the Rb-Sr data.

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LATE CARBONIFEROUS CYCLOTHEMS IN THE SYDNEY COALFIELD[1]

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Cyclothems are repeated sequences of strata, each sequence a few tens of metres thick, that include sandstone, shale, limestone and coal. They were first documented fully in 1912 in Illinois, where the coal and limestone beds can be mapped over enormous areas. The cyclothems represent repeated marine transgressions and regressions that may reflect regional (global?) changes in sea-level or absolute level of the continent. Their identification and analysis can lead to the formulation of models for investigating the distribution of coal.

Wanless and Shepard suggested in 1936 that cyclothems were present in the Sydney Coalfield, although marine fossils were not known there at that time. Shale and limestone associated with the coal have recently yielded agglutinated foraminifera, the first marine fossils discovered in these rocks (S.Thibaudeau, M.Sc. in progress).

A detailed analysis of the stratal sequences in the Sydney Mines Formation (Bras d'Or to Point Aconi section) shows that coal-bearing strata (with coal seams up to 1.2 m thick) alternate with strata that contain beds of red mudstone several metres thick. Individual beds of both types can be traced for tens of kilometres across the basin. This distribution is interpreted to reflect alternate periods of drowning (peat, associated leaf- and bivalve-rich beds) and exposure (oxidation, soil formation) of the landscape. The onshore strata are divided into 11 cyclothems about 20-70 m thick, which may be of great extent: P. A. Hacquebard has shown that coal-bearing intervals equivalent to those at Sydney can be traced across the Gulf of St. Lawrence Basin.

Recent palynological dating by Graham Dolby has shown that the Westphalian D stage (3 m.y. duration from dating of tonstein units in Europe) is represented by 450 m of strata at Bras d'Or. From this, we estimate mean cyclothem duration to have been 220,000 - 300,000 years, although such estimates are subject to large possible errors. These values accord reasonably well with Milankovitch cyclicity (systematic variation in solar energy reaching the earth, with orbital eccentricity periodicities of 100,000 and 400,000 years). The waxing and waning of southern hemisphere ice-sheets in response to the Milankovitch cycle during the Late Carboniferous, with associated variation in sea-level, may account for the development of cyclothems in the Sydney Coalfield, which was located near the paleo-equator.

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PETROGENESIS, AGE AND ECONOMIC POTENTIAL OF GABBROIC INTRUSIONS IN THE AVALON TERRANE OF SOUTHEASTERN CAPE BRETON ISLAND AND SOUTHERN NEW BRUNSWICK

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In southern Cape Breton Island gabbroic plutons occur in the Baleine Cove area (Baleine gabbro) and in the St. Peters area (St. Peters gabbro). Several possibly related but smaller gabbroic intrusions also occur in the region.

The Baleine gabbro has a maximum age of Late Hadrynian to Early Cambrian based on its intrusion of the Main-a-Dieu sequence of volcanic and sedimentary rocks. The gabbroic rocks are typically homogeneous, and consist of clinopyroxene and plagioclase of andesine-labradorite composition.

The St. Peters gabbroic intrusions are of uncertain age; however, they are at least older than overlying Carboniferous sedimentary rocks. They range in composition from olivine gabbro to hornblende-bearing pyroxene gabbro and leucogabbro. Felsic rocks also occur in association with the gabbro.

In New Brunswick, gabbroic plutons occur in the Mechanic Settlement area (Mechanic Settlement Gabbro) and the St. John area (Duck Lake Gabbro). Studies by the Geological Survey of Canada have shown that the Mechanic Settlement intrusion consists of mafic and ultramafic rocks (peridotite, troctolite, olivine gabbro and more evolved compositions). It includes at least three cyclic units, each beginning with peridotite. Platinum group element (PGE) mineralization occurs in two zones with PGE grades up to 2.6 g/t. Platinum group minerals identified were vysoscite, merenskyite, nichenerite, sperrylite, stillwaterite and hollingworthite. Cu/Ni and Pt/Pd ratios and chondrite-normalized plots of PGE concentrations of the Mechanic Settlement sulphides are similar to those in flood basalt-related ores. The probable age of this intrusion is Late Hadrynian to Early Cambrian, similar to the Baleine gabbro. The Duck Lake Gabbro consists of medium- to coarse-grained gabbro and anorthositic gabbro. It is a small, layered intrusion similar to the Mechanic Settlement intrusion.

Major goals of this project are to compare and contrast these gabbroic intrusions in terms of their age, petrography, petrology and metallogenesis, and in particular to assess the potential of the Baleine and St. Peters gabbros for platinum group elements.

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ICHNOLOGY, SEDIMENTOLOGY AND STRATIGRAPHY OF CARBONIFEROUS STRATA IN WESTERN CAPE BRETON ISLAND, NOVA SCOTIA[1]

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Typical *Scoyenia* ichnofacies have been identified at two major localities within the Carboniferous strata of western Cape Breton Island between Cheticamp and Inverness.

Examination of the coastal section at Grand Etang has recovered a trace fossil suite comprising *Helminthopsis isp.*, *Palaeophycus striatus*, *Palaeophycus isp.*, *?Planolites isp.*, *Cruziana problematica*, *Circulichnis montanus*, *Rusophycus didymus*, *Skolithos isp.*, *?Ancorichnus isp.* and several unnamed meniscate burrows, tracks and possible vertebrate footprints, which occur primarily in red siltstone or thin grey sandstone assigned to the Mabou Formation (Canso Group). Their non-marine origin is confirmed by the presence of rain drop imprints, desiccation cracks and possible soil horizons.

A low diversity ichnocoenose is similarly encountered in interbedded red siltstone and grey sandstone near Broad Cove. Trace fossils identified include *Rusophycus didymus*, *Cruziana problematica*, *Helminthopsis isp.*, *Palaeophycus striatus*, *Stiaria intermedia*, *Gordia marina*, and *?Planolites isp.*, together with unnamed tracks, and possible meniscate burrows and vertebrate footprints.

Currently, this latter sequence is assigned to the Port Hood Formation (Riversdale Group), although it comprises predominantly red siltstone and current rippled, fine-grained sandstone, closely resembling the Mabou Formation. Other Port Hood Formation strata exposed between these two localities are dominated by grey, fine- to medium-grained, predominantly cross-bedded or soft-sediment deformed sandstone of fluvial origin, containing abundant plant detritus. Palaeocurrent analysis, which indicates southeasterly and southerly palaeoflow directions, fails to distinguish between the respective sequences. Further investigation into the petrology and biostratigraphy of the strata may help resolve the problem. Re-assignment of the Broad Cove section to the Mabou Formation would, however, simplify the structural interpretation of the area.

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THE STRUCTURAL EVOLUTION OF THE EASTERN HIGHLANDS SHEAR ZONE IN CAPE BRETON ISLAND, NOVA SCOTIA[1]

S. Lin[2] *and P. F. Williams*[2]

The Eastern Highlands Shear Zone was first reported by Barr *et al.* (1987) as the boundary between the Aspy and the Bras d'Or terranes. Our detailed structural mapping has revealed a greater width and a complicated history.

The earliest recognizable and probably the most important movement along the shear zone is characterized by a strong high-grade deformation zone up to 10 km wide. Sheath folds are very well developed and the vergence of the folds consistently indicates an oblique movement with a dextral horizontal component and a northwest side up and southeast side down vertical component. This high-grade deformation is Late Silurian in age. It deformed Ordovician to Silurian rocks, but is stitched by Devonian plutons.

After intrusion of the Devonian plutons, deformation along the shear zone was low-grade and concentrated in the metasedimentary-volcanic rocks between the Devonian plutons and earlier plutons and within the margins of the plutons. Classical mylonites with dynamic recrystallization structures are very well developed. Earlier high-grade rocks were converted to phyllonites by deformation and retrograde metamorphism. Porphyroblasts are still preserved in less deformed areas of fold closures. Many well developed kinematic indicators indicate that the sense of movement during this low-grade deformation is the same as that of the high-grade deformation (i.e. an oblique movement with a dextral horizontal component and a northwest or north side up vertical component). The high-grade and low-grade oblique dextral movements may represent two episodes of an essentially continuous deformation; the Devonian plutons would then be syntectonic.

Locally developed, small-scale sinistral shear zones and shear bands show that there was also sinistral movement along the Eastern Highlands Shear Zone, post-dating the dextral movement.

All these ductile structures are unconformably overlain by a Carboniferous conglomerate, which is not involved in the ductile deformation but is cut by a large-scale brittle fault. This fault is parallel to the Eastern Highlands Shear Zone and probably resulted from reactivation of the zone. Because of the normal component of movement on the fault, the high-grade mylonite outcrops to the northwest and the low-grade mylonite-phyllonite to the southeast of the fault.

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RECENT RESEARCH ON THE BLAIR RIVER COMPLEX, CAPE BRETON HIGHLANDS, NOVA SCOTIA[1]

B. V. Miller[2]

The Blair River Complex (BRC) forms the northwestern corner of a 'collage' of lithotectonically distinct packages on Cape Breton Island. This collage is considered by some workers to expose various levels of erosion of the Avalon Terrane, or to represent several components of the Avalon Composite Terrane. In both cases the complex would be Avalonian basement. However, other workers consider Cape Breton Island to display a compressed assemblage of separate terranes, correlatable with other northern Appalachian terranes from New Brunswick to Newfoundland. In this case, the Blair River Complex would represent the Grenvillian (Humber Zone) component of the orogen. Irrespective of the differing interpretations, the complex exposes lithologies unique in Nova Scotia.

Gneiss of the Pollets Cove River Group is perhaps the oldest rock in the complex. The gneiss varies widely in lithology, but is predominantly quartzo-feldspathic with locally significant proportions of amphibolite. Several large syenite bodies occur in the complex, one of which has produced a U/Pb-zircon metamorphic age of ca. 1040 Ma. Marble xenoliths in this syenite host the Meat Cove zinc occurrence as well as other sulphide mineral showings. Anorthosite and anorthositic gabbro of the Red River Anorthosite Complex preserve cumulate textures and compositionally and petrologically resemble massif-type anorthosite of the Grenville and Nain provinces, suggesting a genetic linkage. Recent field mapping suggests that portions of this complex may be tectonically emplaced and the mapping has distinguished between cummulate gabbro related to the anorthosite complex and other nearby mafic intrusive rocks.

The Blair River Complex is bordered by shear zones: the Red River Fault to the southwest and the Wilkie Brook Fault to the southeast. The Red River Fault becomes parallel to the Wilkie Brook Fault in the south. Both are cut by Devono-Carboniferous plutons and late brittle faults before they meet. Geometrically these zones might imply a positive flower structure; however, this is not supported by presently available kinematics. Mylonitic foliations within these shear zones are generally steeply dipping with sub-horizontal mineral lineations where discernible. Sense of shear kinematic indicators was inconclusive in the field but is being investigated in thin section.

Several important questions regarding the relationship of the Blair River Complex to the rest of Cape Breton Island remain unanswered; however, the present study is on-going and includes field mapping, the study of deformational and metamorphic history, and geochemical analysis.

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INTEGRATION OF C BAND RADAR IMAGERY WITH TM, GEOPHYSICAL AND GEOLOGICAL DATA, CAPE BRETON ISLAND

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The synthesis of a multi-layer database incorporating airborne synthetic aperture radar (SAR) and Landsat Thematic Mapper (TM) imagery, along with conventional geophysical and digital topographic data, has been instrumental for the structural interpretation of sedimentary basins in southwestern Cape Breton Island.

The study area, contained within the south-central portion of N.T.S. map sheet 21F/14, covers 440 km^2. It is flanked to the north by the Creignish Hills and to the south by the North Mountain. The area consists of Lower Carboniferous to Upper Carboniferous Windsor and Mabou Group rocks. Prominent structures visible within the original remotely-sensed data include the Maple Brook Syncline and the horst and graben fault structure controlled by movement within the Precambrian basement.

The Canada Centre for Remote Sensing airborne SAR C band imagery was acquired over the area in 1987 along two opposite-looking, northeast-tracking flight lines. This has allowed the opportunity to evaluate the effectiveness of two complimentary radar directions to detect the presence of significant geological features. Local enhancement procedures performed on the corrected radar data, specifically median filtering, have been instrumental in the observation of the following geological features:

1. Both look directions are complimentary; data shadows are minimized allowing the extension of geolinear features.

2. The extensive open folding can be observed in both radar directions, especially in the south-looking band where the Maple Brook Syncline and a circular feature to the northeast of this fold can be observed within the basin.

3. The sharp linear contact between the folded basin and the Devonian/Precambrian Creignish Hills and North Mountain supports the graben origin for the basin.

4. Extensions of the lineaments within the highland areas continue into the sedimentary basin and truncate the Carboniferous folds.

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A RECONNAISSANCE GRAVITY SURVEY OF THE WESTERN PART OF THE LISCOMB COMPLEX[1]

P. J. C. Ryall[2]

Semi-detailed gravity coverage has been extended south from the area reported by Ryall & Brogan (1989) to cover the entire western part of the Liscomb Complex described by Giles & Chatterjee (1987). Uncertainties in elevation of ± 3 m at some stations cause a probable error of up to 0.5 mgal. Station spacing in some areas is still sparse, so some contours may be subject to revision.

A qualitative examination of the Bouguer gravity map reveals several features:
(1) A gravity low (-14 mgal) centred at 45°11'N, 62°43'W. This low is located over the Moose Lake leucomonzogranite. Although not well controlled to the east, the gravity anomaly is much larger than the outcrop extent and suggests that the Moose Lake body underlies much of the surrounding Pogue Lake metamorphic suite.
(2) A band of relatively high gravity running almost east-west, just south of 45°10'. This band is associated with the dense Halifax slate.
(3) Neither the Ten Mile Lake nor the Bog Island Lake gabbro produce a large gravity signal. Thus, while there undoubtedly are dense rocks in these bodies, they are unlikely to be volumetrically significant.
(4) The southern part of the map shows the northern limit of a gravity low associated with the Beaver Lake granite to the south.

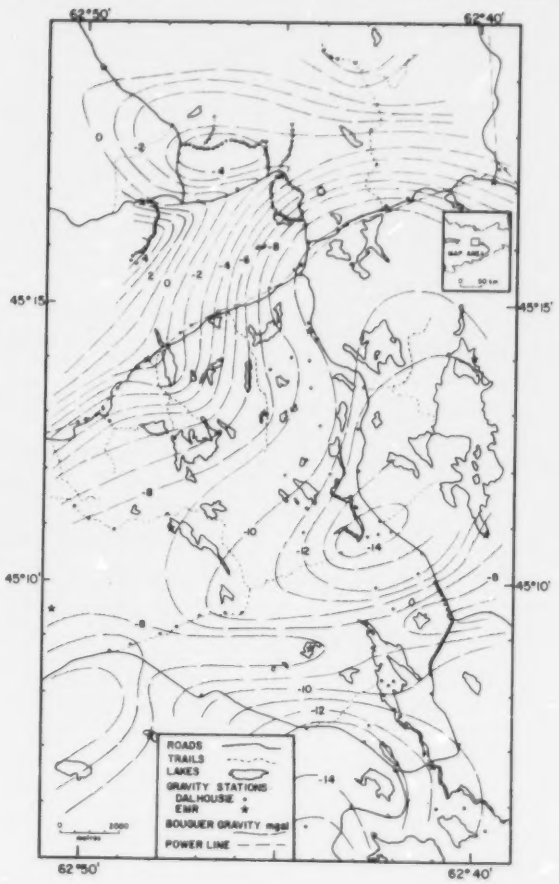

Figure 1. Bouguer gravity map of the western part of the Liscomb Complex. Contours in mgal.

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EVENT STRATIGRAPHY, SEA-LEVEL CHANGES AND SEQUENCE STRATIGRAPHY OF THE MEGUMA ZONE, NOVA SCOTIA[1]

P. E. Schenk[2]

The stratigraphic succession of the Meguma Zone consists of thick, siliciclastic and volcaniclastic strata deposited from late Cambrian through Early Devonian time on the continental margin of Gondwana. Grain size of the major stratigraphic units reflects the changing elevations of base-level in the source region. The 12 major events in the Zone can be related to changes in relative sea-level and combined into four major transgressive-regressive cycles. Stratigraphically they are equivalent to the Meguma Group and each of the White Rock, Kentville/New Canaan and Torbrook formations.

Each cycle begins with a basal sandstone, followed by a black shale, and ends with a siltstone and/or sandstone. An exception is the third cycle (Silurian) in which the basal sandstone is absent. The five sandstone units were deposited during times of low sea-level. Deep-water sandstone of the Goldenville Formation corresponds to emergence of the adjacent source craton, possibly due to glaciation of Gondwana. The overlying sandstone in the White Rock and Torbrook formations was deposited in storm-swept, shallow water of the upper part of the Gondwanan continental embankment. The absence of a basal sandstone in the Silurian sequence is probably due to rapid submergence caused by melting of the Saharan ice sheet. The five thick units of black shale represent anoxic conditions. At least two of them (in the Halifax and Kentville formations) represent oceanic anoxic events of non-polar times. The remaining three anoxic episodes in the upper Goldenville, middle White Rock, and middle Torbrook have regional importance and form third-order cycles.

Each cycle is terminated by igneous activity, usually in the form of subaerial volcaniclastics but also extrusive sheets. Their stratigraphic positions between underlying regressive and overlying transgressive successions suggest paraconformities. The units indicate subaerial exposure and probable significant hiata. Thus they are bounding unconformities and the cycles are sequences.

The Meguma's four sequences are similar in age to cratonic sequences (e.g. the Sauk, Tippecanoe and Kaskasia) except for (1) subdivision of the Tippecanoe by the Saharan glacioeustatic sea-level low and (2) interruption in the lower Kaskasia by the Acadian unconformity. Third-order cycles suggest idiosyncrasies of the source land. Ultimate cause of the Meguma cycles may be mantle activity that affected continental base-level, relative sea-level and direction of continental drift. The Meguma curve is similar to that of northwest Africa. This supports sedimentological, stratigraphic and geophysical interpretations that the Meguma Zone was deposited as the continental margin of Gondwana, specifically that of northwest Africa.

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CARBONIFEROUS DEEP-WATER, BACTERIAL PRECIPITATED, PELOIDAL LAMINITE (THE MACUMBER FORMATION) AND CHEMOSYNTHETIC, MICROBIAL MOUNDS (THE GAYS RIVER FORMATION)[1]

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The Macumber Formation is a black, peloidal, laminated carbonate to calcareous shale that extends as a single but discontinuous and interfingering unit from Nova Scotia and New Brunswick into Newfoundland as the Ship Cove and Big Cove (in part) formations. With the laminite or laterally equivalent to it are scores of up to 110 m thick, microbial mounds: the Gays River, Parlee and Big Cove (in part) formations. These are characterized by high initial porosities and, in some places, thickets of bryozoa and probable vestimentiferan tube worms. Dense nests of brachiopods are common associates. The peloidal laminite is interbedded locally with siliceous and carbonate turbidites, debris flows and chaotic slump deposits. A Nereites ichnofauna has been found. In places, the sub-carbonate surface has steep initial dips.

The peloidal laminite is a deep-water, marine pelagic ooze precipitated by anaerobic bacteria within a restricted, euxinic water mass in a continental setting. Seasonal changes in anoxia and/or carbonate production produced rhythmic laminations. Carbonate laminae were cemented very early, and partially dissolved by humic acids during early diagenesis. This host environment was interrupted by influxes of siliciclastic sediments carried by resedimentation processes that include sliding, slumping, debris flows and turbidity currents. The laminite also shows common, incipient brecciation due to downslope creep that can accumulate as thick stratiform breccia (e.g. the Pembroke Formation, in part). The bacteria, perhaps concentrated over underwater, marine, hydrothermal springs or in topographic depressions, locally supported chemosynthetic communities that built calc-sinter-like mounds. These mounds trapped petroleum from underlying seeps as well as from the surrounding laminite. Sulphides deposited within the mounds may also be products of methanogenic bacteria. The combinations of large, poorly connected, restricted bodies of water in an equatorial setting, and low precipitation on and/or low relief of the surrounding land, led to progressive evaporation and precipitation of thick masses of sulphate and halite. The Macumber and Gays River formations are similar in stratigraphic setting to units in the Zechstein, Michigan and Williston basins.

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STRATIGRAPHY, STRUCTURE, METAMORPHISM AND TECTONICS OF THE CAPE NORTH AND MONEY POINT GROUPS, NORTHERN CAPE BRETON HIGHLANDS, NOVA SCOTIA: A PRELIMINARY REPORT[1]

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Rocks assigned to the Cape North Group are semipelitic, pelitic, and calc-silicate gneiss, with minor amounts of amphibolite, marble and mylonite. The major lithologies in the Money Point Group are mafic (amphibolite and hornblende-biotite schist) but there are also significant proportions of semipelite, pelite, calc-silicate rock and rare marble. These two groups have been abundantly intruded by granitic dykes, sheets and pegmatite (e.g. Wilkie Sugarloaf granite, which is probably a Devonian pluton).

The Cape North and Money Point groups appear to have been deformed together throughout the Aspy terrane. In all areas where the two units are exposed in close proximity, they display similar fabric development and similar late-stage structural effects. At least three different phases of folding have been recognized. F_1 folds are moderately inclined to upright isoclinal folds with axial plane cleavage. F_2 folds are upright to gently isoclined, close to tight folds approximately coaxial with F_1 folds. F_3 folds are open to close folds with rounded to chevron shapes and associated numerous sets of kink bands.

The metamorphic grade increases rapidly from east to west across Cape North peninsula. The semipelitic and pelitic rocks display the effects of amphibolite facies Barrovian metamorphism (a sequence of zones involving staurolite, kyanite, biotite and sillimanite). Low-grade assemblages also include cordierite, garnet, biotite and chlorite. To the east of the Aspy Fault, metamorphic grade increases from west to east, from a narrow belt of staurolite-kyanite zone rocks into a zone of kyanite-bearing lithologies. Sillimanite zone rocks underlie the areas to the south. Many specimens from the Cape North and Money Point groups show development of large, coarse grained muscovite, indicating a period of mid-amphibolite facies retrograde metamorphism.

The Cape North and Money Point groups appear to be Silurian or older. They have been extensively intruded by varied granitic rocks which range in age from Silurian to possibly early Carboniferous. Many of these show characteristics of crustal-derived plutons and appear to be related to crustal thickening and post-collision extension.

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QUATERNARY GEOLOGY AND TILL GEOCHEMISTRY, MIRA-FRAMBOISE AREA, CAPE BRETON ISLAND[1]

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The rocks of southeastern Cape Breton Island host the Yava and Stirling base metal deposits and there is potential for other deposits, but outcrop is sparse and drift cover reduces exploration success. For drift prospecting to be effective here, more data are needed on the provenance and geochemistry of the tills associated with several superimposed ice flow events. This project is designed to provide those data, in support of detailed drift prospecting and till and soil geochemistry surveys that may be carried out in future. It will also provide baseline geochemical data against which data sets on other sample media can be evaluated, and will contribute to other joint federal-provincial geochemical projects in the area (e.g. Geological Survey of Canada biogeochemistry study and Nova Scotia Department of Mines and Energy site-specific studies).

A brief reconnaissance was completed in the Mira (NTS 11F/16) and Framboise (11F/9) areas, in preparation for a full field season in 1991. Detailed sampling of soil profiles developed on till was carried out at the Deep Cove occurrence (Mo-Ag-Bi-Cu), the Copper Shaft occurrence (Cu-Zn-Sn-Bi), the MacIntyre Lake occurrence (Cu-Zn-Bi), the MacDonald Lake occurrence (Pb-Zn), and the Yava deposit (Pb-Ag-Ba). About 100 channel samples were collected to cover 10 to 20 cm intervals from the top of the B-horizon into the C-horizon of the soil profile. Analysis of the < 0.063 mm fraction is under way, followed by analysis of the heavy mineral fraction and other grain size fractions from selected samples. This work should indicate which part(s) of the soil profile and which size fractions are suitable for use in the till geochemistry survey planned for 1991.

About 50 samples of fresh till were collected, from coastal sections around Gabarus Bay, in an attempt to identify shifts in provenance that might be recognized in the composition of the till. In one visually uniform 15 m till section, pebble fabrics record a shift in ice flow from eastward to north-northeastward, which agrees with the shift in ice flow recorded by striae on nearby outcrops. This type of field work, aimed at producing a map of the till types and data on their provenances, will continue in 1991.

In addition to the mapping and till geochemistry survey, further detailed sampling will be carried out around known mineral occurrences (e.g. Deep Cove, Stirling), and a three-dimensional dispersal study will be carried out by drilling in selected areas of metal-rich till.

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SURVEYS IN NOVA SCOTIA USING THE ANALYSIS OF TREE TISSUES FOR GEOCHEMICAL EXPLORATION AT RECONNAISSANCE AND DETAILED SCALES[1]

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Under the previous mineral development agreement (Canada - Nova Scotia Mineral Development Agreement 1984-1989) between the federal and Nova Scotia governments, a biogeochemical survey was conducted over a 5000 km^2 area extending from Beaver Dam eastward to Canso (Dunn *et al.*, 1989). Results showed that from an average sample density of 1 site per 8 km^2 the analysis of balsam fir twigs proved successful in delineating all known zones of gold and arsenic mineralization, and indicated other areas with metal concentrations of similar magnitude warranting examination. On a detailed scale gold and arsenic analyses of spruce bark samples from Beaver Dam outlined a zone of gold enrichment in till. The bark analysis provides a quick and economical method of identifying targets for closer investigation by, for example, more labour-intensive, close-spaced sampling of tills for the heavy mineral concentrates that are of value in locating mineralized bedrock (Dunn *et al.*, in press).

Surveys of similar type are planned for the latest federal-provincial Cooperation Agreement, commencing in the early summer of 199[illegible] The focus will be on two areas:

(a) A reconnaissance-scale biogeochemical survey, at 1 site per 4 - 8 km^2, over most of the Meguma Terrane westward from Bridgewater. Sample density will depend on ease of access by drivable roads and trails. Some emphasis will be placed on the area of the Davis Lake and Wedgeport plutons.

(b) In the Mira/Framboise area of southeastern Cape Breton Island, samples will be collected in conjunction with, and at a similar density to, the till geochemistry project of DiLabio (this volume). A close link between the biogeochemical survey and a study of the Quaternary deposits and their chemistry will help in the interpretation and understanding of the metal patterns revealed by tree analyses. The biogeochemical signatures over known mineral deposits of the area will be established in order to look for other zones with similar patterns of metal enrichment that might, by analogy, be related to mineralization. The biogeochemical method is especially useful in areas with little bedrock or till exposure where other geochemical methods of exploration are impractical, or where they are difficult and costly to apply.

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NEARSHORE NOVA SCOTIA STUDIES FOR MARINE PLACERS AND AGGREGATES[1]

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As partners in a Cooperation Agreement on Mineral Development program with the Province of Nova Scotia, the Atlantic Geoscience Centre has initiated a study of the marine placer and aggregate potential of the nearshore. Previous geophysical and geological surveys have been conducted in Scots Bay, off Yarmouth, Halifax Harbour, Sheet Harbour and Sydney. Interpretation of the data indicates that large quantities of sand and gravel, suitable for use as construction aggregates, exist in some of these areas. The placer gold potential has not been properly assessed.

The Scots Bay area, at the upper reaches of the Bay of Fundy, contains upwards of 35 million cubic metres of coarse sand that has potential for aggregate use. The deposit occurs in a large sand wave field referred to as the 'Scots Bay Sand Wave Field' in water depths of approximately 40 m. Large sandy bedforms, up to 20 m in height, overlie a lag gravel surface developed on glaciomarine/lacustrine sediments. The sand contains 5% biolithic material and consists mainly of quartz fragments, some of which are iron stained and likely derived from local Triassic bedrock. The other sand-sized particles consist of red sandstone, feldspar and metasediments. A central zone of convergence occurs in the sand wave field, where the bedforms indicate sediment transport to the centre of the field, suggesting that it is stable and in equilibrium with the strong tidal currents in this area of the Bay of Fundy.

Field activities in the second year of the Cooperation Agreement program will be undertaken in the nearshore off Lunenburg, Halifax Harbour, Sheet Harbour and Country Harbour. The program will attempt to collect large surface and subsurface samples adjacent to known onland occurrences of gold. Sidescan sonar mosaics will be produced in a series of transects from the headlands to the inner shelf basins. High resolution seismic reflection profiles will be collected to determine the stratigraphy and the presence of sediment transport pathways in the subsurface. A geomorphic classification for the inner shelf will be proposed and the sea level history will be constructed in order to understand the processes that contributed to the development of placers and aggregates in the nearshore of the south coast of Nova Scotia.

1 Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

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STRUCTURAL CONTROL OF GOLD MINERALIZATION IN THE CAPE BRETON HIGHLANDS: PROGRESS REPORT 1990[1]

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This study of the relationships between major structural features and gold occurrences in the Cape Breton Highlands is part of a regional project aimed at investigating structural control on gold mineralization in the Canadian Appalachians. During the summer, a large number of gold occurrences were visited in the Aspy and Bras D'Or terranes of Nova Scotia. In addition, because an understanding of the larger scale structures is deemed essential for interpretation of local structures, detailed studies were carried out in the tectonic zone separating the two terranes. Selected results from the study are outlined below.

The majority of gold occurrences in the Aspy terrane are found in the Chéticamp area, where they occur in a ca. 40 km long belt underlain by the Ordovician-Silurian Jumping Brook Formation. Mineralization (Py, Cpy, Po, Aspy, Sp, Ga) is semimassive and occurs where felsic and mafic metavolcanics interdigitate with metasediments. Gold values up to 0.14 oz/t have been reported. Structurally, the mineralized zones are stratabound and occur as cm-scale layers in thick ($\leq$10 m), variably mylonitized sericite schist. Field and microstructural observations suggest a pre-metamorphic (presumably syn-depositional) origin for the mineralization. Kinematic indicators in mylonites and phyllonites show an overall contractional (N-S) tectonic regime, with S-directed thrusting along gently N-dipping planes.

A major shear zone separates the Aspy and Bras D'Or terranes in the southern Cape Breton Highlands. The Southern Highlands Shear Zone (SHSZ) is composed predominantly of felsic mylonites and phyllonites and is up to 1.5 km wide. Previous workers have interpreted the SHSZ to be coextensive with the Eastern Highlands Shear Zone (EHSZ) defined to the northeast. Preliminary results of this study fail to establish this link, but instead suggest that (splays of?) the SHSZ more likely represent(s) the southern extension of the Wilkie Brook Fault separating the Blair River Complex and Aspy terrane farther north. Kinematic indicators in the SHSZ suggest ESE-side-up along subvertical stretching lineations, contrasting with the NW-side-up vertical component shown for the EHSZ. All SHSZ mylonites are characterized by (1) steep mylonitic foliations and lineations, overprinted by (2) vertical folds showing both dextral and sinistral asymmetry locally. (3) Late brittle fracturing, characterized by open space tension gashes, is ubiquitous. Mylonitized sericite schist in the southern part of the SHSZ locally contains up to 10% fine grained, pre-kinematic pyrite.

Base metal and gold occurrences in quartz and/or carbonate veins are known throughout the Bras D'Or terrane. In the St. Anns area, the veins occur in Cambrian granitoids and Late Proterozoic felsic-intermediate extrusives. The Price Point mineralization (Py, Cpy, Aspy) occurs in steep, cm-scale veins and ENE-dipping tension gashes developed in dacitic crystal/lithic tuff along steep NNW-SSE faults (E-side-up). At Murray Point, networks of cm-scale sericite zones with thin quartz veins (Py, Cpy) occur in undeformed granitoids. Alteration zones and veins at Goose Cove Brook (Py, Cpy, Mo) cut a porphyritic granite and occur in steeply E-dipping sinistral faults with minor reverse components. Quartz-carbonate veins at Elders Brook are moderately ESE-dipping and contain Py, Cpy and Sp. Significant reverse movements along the veins are indicated by slickensides and mineralized, quartz-filled, subhorizontal tension gashes.

Future work on the gold occurrences is aimed at further characterizing the contrasting styles of mesothermal vein mineralization in the Bras D'Or terrane and the generally stratiform mineralization in the Aspy terrane.

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PRELIMINARY REPORT ON THE RELATIONSHIP BETWEEN MINERALIZATION AND CARBONATE DIAGENESIS IN THE GAYS RIVER FORMATION, NOVA SCOTIA[1]

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On mainland Nova Scotia, the syndiagenetic Pb-Zn deposit near Gays River occurs in basal dolostone of the Viséan Windsor Group, an extensive unit occurring throughtout the Maritimes Basin. The host rocks occur on a basement ridge separating the Shubenacadie and Musquodoboit sub-basins. They belong to the Gays River Formation, composed of numerous banks of wackestone, packstone and algal and bryozoan bafflestone. On a regional scale, the aim of this study is to evaluate the relationships between mineralization and diagenesis of the Gays River Formation. This preliminary report focuses on the petrography of diagenetic dolomite and calcite.

Microscope, scanning electron microscope (SEM) and cathodoluminescence (CL) studies and staining tests established the following succession of events: (1) cementation by inclusion-rich, isopachous early marine cement, (2) replacement by microdolomite, (3) partial dissolution and corrosion, (4) cementation by rhombohedral dolomite, (5) precipitation of sphalerite, contemporaneous with fracturing and brecciation, (6) precipitation of sulphates, (7) cementation by inclusion-free, xenomorphic calcite and (8) stylolitization. The first generation of dolomite totally replaced the marine substratum (mud, fossils and early calcite cement). It consists of anhedral to euhedral, fine (1 to 10 micrometres), iron-free and uniformly dull (CL) microrhombohedrons. On the other hand, the succeeding, pore-filling dolomite is invariably euhedral, coarser (10 to 50 micrometres), iron-free to poor and generally nonluminescent. Fracturing, brecciation and precipitation of sphalerite appear to be contemporaneous events, succeeding pore-filling dolomitization. The last cement, an inclusion-free, coarse xenomorphic (up to 1 cm) iron-free to rich calcite, fills microfractures and encompasses brecciated fragments, sphalerite and rare occurrences of sulphates. It is always postdated by stylolites. In cathodoluminescence, the late calcite comprises two distinct zones. The first one is characterized by alternating dull to luminescent fine layers and the second one is made up of uniformly luminescent overgrowths.

These petrographic results for the Shubenacadie and Musquodoboit sub-basins will guide the regional micro-sampling for isotopic and elemental geochemistry. The same systematics will be applied to undolomitized to partially dolomitized limestone of the Gays River Formation in the Antigonish Sub-basin and Mahone Bay area.

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YARMOUTH AREA AEROMAGNETIC/GRADIOMETER/VLF-EM SURVEY[1]

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Under the Canada - Nova Scotia Mineral Development Agreement (1984-1989) 30,000 line-kilometres of aeromagnetic/gradiometer/VLF-EM data have been acquired in the Yarmouth area. The survey covers the part of the Province that lies south of 44°15'N and west of 65°W.

Flight lines spaced at 300 m intervals were oriented N65°W to intersect the dominant geological trend. Control lines were flown every 3 km and all data were collected at a mean terrain clearance of 150 m. A significant amount of new lithological and structural information is readily apparent in this data set. The relationship between the formations in the Meguma Group and the intruding granites is well defined, as is the associated faulting.

The survey results are available as digital profile and gridded data, as well as map products. Gradiometer and total field magnetic contour maps and VLF-EM profile maps are available at 1:20 000 scale. Gradiometer and residual total field magnetic colour maps are available at 1:50 000 scale.

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